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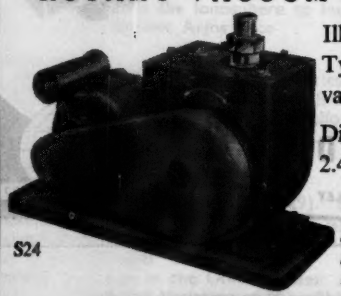

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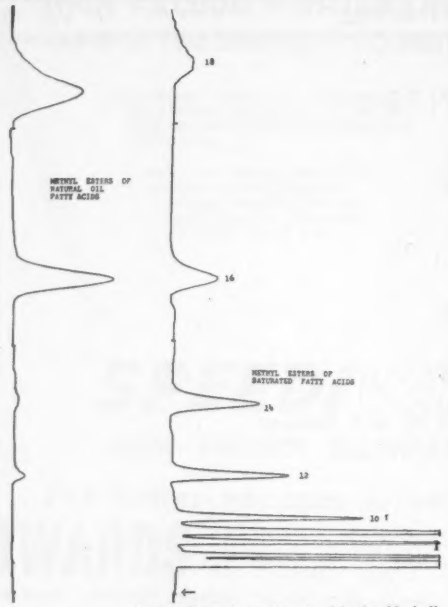

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SCIENCE AND TECHNOLOGY IN DEFENCE

THIS year's White Paper dealing with defence entitled "Report on Defence, 1958"*, with the sub-title "Britain's Contribution to Peace and Security", outlines the progress made in implementing the policy announced in the Defence Statement last year and summarizes the Government's general attitude to the problem of disarmament. Apart, however, from a paragraph in the section dealing with collective defence and another in that dealing with the nuclear deterrent, there is little indication in this report of the extent to which effective defence to-day is based on science and technology, still less of the way in which scientific and technical developments affect both foreign policy and the strategy and tactics of defence which that policy determines. The successful launching of artificial satellites by the U.S.S.R. is noted as evidence of her remarkable progress in rocket development; but, instead of pausing to consider its implications for Britain and her allies in the widest context, the report merely observes that it should not be thought that this has upset the "balance of military power".

That observation may be trite and also true, but it is not the vital point. "Never in peace-time has the British soldier, sailor or airman had a more vital part to play. Never has he more deserved the respect and encouragement of all those who live their daily lives under his protection." That deserved tribute was welcomed by both political parties in the recent defence debates. What needs to be emphasized no less firmly is that whether that part is to be played effectively depends also on the scientist and technologist, and the efficiency with which scientific and technological knowledge and advice are presented at the appropriate levels, from that of policy-making to those of strategy and of tactics.

The White Paper on defence gives no sign of such awareness, and the absence of any reference at all to the Defence Research Policy Committee suggests that the Government has not, even in the face of the debate about the nuclear deterrent, grasped the vital importance of the contribution of science and technology, or started to consider whether the present organization is adequate either in relation to our own needs or to those of collective defence.

It is true that full recognition is given to the principle of interdependence which the Prime Minister and the President of the United States emphasized so strongly in their joint statement last October. If the full benefits of collective defence are to be achieved, the members of the North Atlantic Treaty Organization (the governments of which have already endorsed the concept of interdependence in defence planning of all kinds), as well as those of the Baghdad Pact and the South East Asia Treaty Organization, must accept this increasing and inextricable dependence, although it will raise numerous and varied military, economic and political problems. There is little evidence of progress during the past year, but within the North Atlantic Treaty Organization, at least, the White Paper suggests that it should be possible gradually to discard the idea that every member nation must continue to build up self-contained national forces, which by themselves are fully balanced, and instead each should seek to make the most useful contribution it can to the combined forces of the alliance as a whole.

The advantages of collective action in the technical and industrial fields are equally great. The members of the Organization possess between them the world's greatest manufacturing and scientific capacity, and the joint planning of weapon research and production offers considerable economies in time and resources. Technical studies are already proceeding in this subject within the framework of Western European Union with the French, German and Dutch Governments, and it is intended later to establish appropriate machinery to co-ordinate these bilateral efforts. Close co-operation is being maintained on numerous projects with Canada and the United States, and if the latter's Atomic Energy Act is amended, the scope for fruitful collaboration will be greatly extended, and the Government proposes in that event to review the British nuclear research and development programme with the object of eliminating duplication and ensuring the most effective contribution to the joint needs of the Western Alliance.

That is as far as the report on defence goes towards recognizing the fundamental importance of science and technology in defence, whether in relation to research and development or to strategy and tactics. Britain's expenditure on the strategical bomber force and its nuclear bombs and on related research and development (including work on ballistic rockets) is estimated at less than one-tenth of the Defence Estimates for 1958–59. Expenditure on the fighter force and the control and warning system, together with research and development on fighters and defensive guided missiles, is about the same; and it is not expected that the total cost—15–20 per cent of the present £1,465 million of the Defence Estimates—is likely to increase in the next few years.

Nowhere, however, does the report give any clue as to the breakdown of this research and development effort, its demand for trained man-power and the deployment of the man-power between establishments and departments and between the Government and industry. Nor was it attempted by Lord Selkirk, in referring to research and development in the earlier defence debate on January 22, though he stated that much of the preliminary work on co-operation in the production of weapons had already been completed.

* Report on Defence: Britain's Contribution to Peace and Security. Pp. ii+13. (Cmnd. 363.) (London: H.M. Stationery Office, 1958.) 1s. net.

It is impossible for an independent judgment to be formed as to the appropriateness of existing organization, the extent of overlapping of either resources or man-power, the effectiveness of communication of information or ideas, or whether conditions are such as to stimulate and encourage creative work and effective co-operation. Nothing can be found to offset the misgivings that have been aroused, for example, by the criticisms of the Select Committee on Estimates, or the disclosure in the debate on the Navy Estimates on March 13 that work has been stopped on the Isaac Newton telescope. Even in the debate on defence on February 27, Mr. Nigel Birch was alone in referring to the demands of defence on scientific man-power. Such details are not too trivial to serve as straws which indicate alarming tendencies. It might well be asked what sound and convincing reasons can be found to justify retaining the Royal Observatory under the Admiralty. When, however, long-range research, which the Civil Lord of the Admiralty himself admitted to be of great national importance, is suspended for illusory reasons of national economy, it is obvious that possible advantages are being offset by placing a scientific institution under the control of those who have little understanding of the nature of scientific research and the way in which it must be planned and organized if waste of man-power and resources is not to result.

As has been repeatedly urged in these columns, informed and objective discussion and public understanding of defence policy and measures are only possible if the area of secrecy is held to the minimum. This aspect becomes the more important as Britain seeks to widen and deepen her co-operation with the United States and with other Western Powers. It is, for example, the surest way to avoid misunderstandings and serious divergence. For this reason alone, the organization of the whole defence effort of Britain, and especially that in research and development, particularly on the industrial side, should be displayed as fully as possible so that effective criticism, at least at the professional level, is possible. This is not to suggest that details of weapon technology should be freely available or disclosed, but at least that the conditions should be such as to afford the maximum chance that any duplication of effort will be detected at an early stage, that informed minds can be freely brought to bear on the fundamental scientific and technological problems, and that the conditions of service are such as to encourage initiative, creative thinking and sound judgment.

Doubts as to the existence, by and large, of such conditions cause the functioning of the Defence Research Advisory Committee to be regarded with some misgivings. Such matters as the suspension of work on the Isaac Newton telescope, the appointment of an administrator with no scientific or technical knowledge as head of the Patent Office, and the strong criticism of the Admiralty advanced by the Select Committee on Estimates may be receiving greater weight than their merits warrant. None the less, they are evidence of weaknesses and deficiencies in Britain's organization for research and development, both for defence and for civil purposes, and it is futile to pretend that the Lord President of the Council is adequately provided with the advice or services he needs to discharge his heavy responsibilities in that field. The emphasis placed on the late Lord Waverley's scientific qualifications in tributes paid to him in the House of Lords gives a pointer to one thing that is needed, and President Eisenhower's appointment of Dr. J. R. Killian as a scientific adviser might well stir the British Government to an examination and reorganization of the administrative structure which could offer large contributions both to efficiency and Anglo-American relations.

Although, as in earlier debates on defence or on foreign policy during the past winter, the defence debates in the House of Commons on February 26 and 27 and in the House of Lords on January 22, March 5 and 6 echoed freely views expressed as to the possibility and implication of limited war and graduated deterrents in such books as H. A. Kissinger's "Nuclear Weapons and Foreign Policy", Sir John Slessor's "The Great Deterrent" and G. F. Kennan's Reith Lectures, "Russia, the Atom and the West", the most significant feature of them was the strong support for the idea of some common ground in defence policy. This realization of the danger of involving defence too deeply in party politics, and of the vital importance of some continuity and stability if any defence policy is to be implemented effectively, was emphasized by Mr. E. Shinwell, when he suggested that there might be consultations from time to time between the Government and the Opposition on defence matters; though this suggestion has not been accepted.

We are concerned here with the adequacy of the means by which scientific and technical advice is tendered to the Government at the several levels, with the effectiveness of co-operation between Britain and her allies, with the means and effectiveness with which scientific and technical man-power and resources are deployed and their disposition between defence and civil research, between the Services, Government establishments, the universities and industry. But even in matters of policy, scientific and technical considerations can enter without warning, and for that reason again it is imperative that there should be present at the highest level those capable of evaluating and interpreting such considerations and advice for themselves and not obliged to rely on others. The report on defence is, in fact, a challenge to the nation to see that the whole structure of Britain's organization for scientific and technical research and development is adequate and appropriate to its growing responsibilities, both in defence and in civil affairs, and that it is administered and managed by those competent to understand and use scientific and technical advice. The very stress laid on disarmament in the report gives one hint of the way in which defence and civil affairs are interlocked. Concern was frankly expressed in the debate on the air estimates as to the future of the aircraft industry in view of the reduction of the Royal Air Force. Failure on the part of the Government to act on such a hint as Sir William Farren gave, in

addressing the Parliamentary and Scientific Committee last November, of the need for a policy to exploit the great strength in aeronautical research built up in Britain over the past twenty years, could be disastrous for the industry and the nation alike. Major H. Legge-Burke made a further point about the effect on our communications of such a contraction in the development of military aircraft.

An effective defence policy to-day demands clear vision and foresight so as to anticipate difficulties and take action before public alarm or even panic has made a sound policy impracticable. The need for statesmanship increases; but it must be statesmanship that can take full account of the scientific and technical potentialities as well as dangers, and has the courage and judgment to act in time to prevent public alarm placing further obstacles in the way of what an objective survey shows to be the real need. There is an urgent and continuing task of public education which is impossible in the heat of party politics, and that is an over-riding reason why the discussion and criticism of defence policy should be as objective and unprejudiced as conditions permit. It is no less imperative that secrecy should be restricted as much as possible, and discussion in Britain and with her partners be as uninhibited and penetrating as organization and minds can permit.

CHEMISTRY OF CELLS

Biochemical Cytology

By Jean Brachet. Pp. xi+516. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1957.) 8.80 dollars.

PROF. J. BRACHET's previous book, "Embryologie Chimique", which appeared in 1944, was, with its insistence on the importance of nucleic acids for protein synthesis, one of the great seminal influences which opened the door to many of the most important developments of biology since the War. He has now laid all biologists still further in his debt by gathering together what may be considered the harvest which he then sowed. His new book is based on a course of lectures which he gave at the Indian Cancer Research Centre at Bombay early in 1956, and on the courses which he gives to his own students in Brussels. It treats of subjects many of which have been reviewed by other authors in recent years, but it has the great merit of presenting everything through the eyes of a single person, and he a biologist of great character and originality.

Brachet is nothing if not bold. "We have attempted in this book," he writes, "to present an integrated version of the facts which to-day are known about the morphology and biochemistry of the cell." It is truly a formidable task, as the lengthy bibliographies attached to each chapter show clearly enough; and although Brachet's sheer learning is impressive, and the body of facts related immense, he would probably not pretend that the book is fully exhaustive, or wish it to be judged primarily as work of reference, valuable although many will find it in that role. Its great importance is as an exposition of a coherent body of ideas; ideas, moreover, which are by no means final and rigid, but which often, as it were, throw out lightly defended reconnaissance parties into the unknown. As Brachet writes in the preface: "Hypotheses and personal opinions have not been forgotten, for hypotheses, provided they can be experimentally tested, may become more important than dry facts. . . . Nowadays, some scientists forget that thinking may sometimes be more useful than performing an experiment". Even the most proper and inhibited devotee of "facts, facts, and more facts" should be ready to admit that Brachet's achievements as an experimentalist have earned him the right to expect our interest in his speculations, and there are very few biologists who will be able to read this volume without coming across many most stimulating new ideas.

After a brief survey of modern developments in cytological techniques, Brachet discusses the cytoplasm of the resting cell, emphasizing particularly the great advances which we owe to the electron microscope. The next chapter deals with the nucleus of the resting cell, with an account of the biochemistry of nucleic acids, and the recent studies on the nuclear membrane, the interphase chromosomes, including polytene and lampbrush types, the nucleoli, and the nuclear sap. A long chapter is then devoted to the physics and chemistry of mitosis. The sixth, seventh and eighth chapters cover the nucleic acids in heredity and protein synthesis, nucleocytoplasmic interactions in unicellular organisms, and the nucleus and cytoplasm in embryonic differentiation. After a short chapter on cancer cells, the book concludes with a page or two of 'final remarks'. The work is extremely well illustrated, with numerous beautiful photographs, many of which are previously unpublished; some are documents of Brachet's own experiments, while others have been lent him by colleagues. There is a long, and, so far as I have tested it, reliable, subject index, but no author index.

This is a book of a calibre of which only one or two in biology appear in a decade. It is worth quoting the last paragraph as an indication of the depth of the personality of which it is an expression: "The more we delve into these problems, the more life remains mysterious. All we can do is to contribute by our work to the solution of the biological riddles. But, what we must also do, is to admire, respect, and love life; we must protect it, and not destroy it. We, biologists, must work more than anybody else for peace among men." C. H. WADDINGTON

PHOTOSYNTHESIS

The Path of Carbon in Photosynthesis

By Dr. J. A. Bassham and Prof. M. Calvin. Pp. xi+104. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1957.) 3 dollars.

THE mechanism of reduction of carbon dioxide in photosynthesis was, from the biochemical point of view, almost completely unknown prior to the last War. Now the general nature of the reactions concerned has been established largely due to the work of Calvin and his colleagues, who have brilliantly exploited the long-lived radioactive carbon isotope. This book is a most helpful summary of much of that work, written by two of the investigators concerned.

The central discussion of carbon metabolism in photosynthesis is approached from a general viewpoint and presents the main problems in a form which is intelligible to those with only a moderate biochemi-

cal training. Attention is not confined to the problem of the formation of carbohydrates; the synthesis of fats and proteins is also mentioned. There is a most useful summary of the sources from which each of the enzymes concerned in the postulated carbon cycle have been obtained. Reference is also made to chloroplast structure and the mechanism of energy conversion in photosynthesis.

In a book of this size the specialist will inevitably note many omissions. For example, three killing procedures are mentioned (boiling alcohol, liquid nitrogen followed by boiling alcohol and alcohol at room temperature) but no comparison of the results for a single tissue type is given. This is to be regretted in view of a recent publication from the same laboratory in which new results obtained from cold killing have been described. Also on p. 29 it is stated that "methods of culturing these algæ vary considerably from one laboratory to another. . . . Experience has shown that these variations affect the resulting labelled carbon pattern in some cases causing important intermediate metabolites to occur in vanishingly small concentrations". Some results illustrating this statement would have been of the greatest value to other workers in this field. The investigation of very rapid changes in concentration of intermediates following a change in external conditions represents a notable development of a classical physiological technique. The figure on p. 51 indicates a rapid decrease in concentration of phosphoglyceric acid with lowering of carbon dioxide pressure during the transition phase, but the opposite effect when a steady state is established. This distinction is not made in the text and it is not made clear that the changes during the transition state alone are consistent with the postulated mechanism.

Such points as these will mainly concern the specialist. They should not deter the general reader, who will find in this book a lucid statement of the many researches *in vivo* which culminated in the formulation of a detailed mechanism of carbon reduction which has since in large part been justified by *in vitro* studies.

C. P. Whittingham

AERODYNAMICS

Elements of Gasdynamics

By H. W. Liepmann and A. Roshko. (Galcit Aeronautical Series.) Pp. xv+439. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 88*s*. net.

ONE of the first text-books to be written in English on compressible flow was the "Introduction to Aerodynamics of a Compressible Fluid", by H. W. Liepmann and A. E. Puckett (1947). In view of the rapid development in the subject, the senior author has decided against revising the original book and has joined with A. Roshko in producing the first of two new books on compressible flow. This first volume discusses the fundamentals of gas dynamics. A second more advanced work is to follow, with special emphasis on the aeronautical and missile fields.

The contents of the new book are, in general, similar to those of the "Introduction to the Aerodynamics of a Compressible Fluid" but are considerably amplified. Concepts of thermodynamics, one-dimensional gas dynamics, wave motions, channel flows, general three-dimensional frictionless flows, small perturbation theories, similarity rules in high-speed flow, transonic flow and the method of characteristics are all covered more thoroughly than in the original book. A more general discussion of methods of measurement, reflecting the considerable experimental ability and experience of the team of research workers at the California Institute of Technology, has been added. Other additions, such as those on reacting and dissociating gases, concepts of gas kinetics and slender-body theory, reflect current interest in problems of flight at high speed and low density.

The coverage of all these subjects is comprehensive and rigorous. One would refer in particular to the chapter in which the equations of frictionless flow are concisely and lucidly stated. Less satisfactory are those sections dealing with internal flows in which heat transfer and friction may be important. The analyses of the Fanno and Rayleigh processes are omitted and the idea of introducing the normal shock process as the intersection of the Fanno and Rayleigh lines on the enthalpy-entropy chart is not developed. Although the simple analyses of compressible Couette flows are extremely informative, the discussion of momentum and heat transfer in the turbulent boundary layer (with no reference to Reynolds analogy) is inadequate.

In general, however, the authors are to be congratulated on producing an excellent book on a rapidly developing subject.

J. H. Horlock

RACIAL PREJUDICE

The Race Question in Modern Science

Pp. 373. (Paris: Unesco; London: Sidgwick and Jackson, Ltd., 1956.) 17*s*. 6*d*.

THE publication of this volume is, we are informed in the foreword, intended to be regarded as part of Unesco's endeavour "to lead the campaign against race prejudice and to extirpate this most dangerous of doctrines". The campaign itself was instituted by a resolution of the General Conference, passed in 1950, instructing the Director General "to study and collect scientific materials concerning questions of race; to give wide diffusion to the scientific information collected; to prepare an educational campaign based on this information". The object of the present book is to collect, and to some extent to collate, the opinions of social scientists representing a wide variety of methods of approach and many Western countries to the problems of race and racial differences falling within the general framework of the General Conference's resolution.

The result is to make available in a single volume a series of interlocking points of view, and thus, perhaps, to give the general impression that social scientists are in general agreement in opposing racial prejudice, exploitation and oppression. The concept of race, it is asserted, can only be established in cultural rather than in biological terms so far as human societies are concerned. "All men," it is said, "belong to one mating circle, and share in a common pool of genes. There is thus no biological justification for race hatred or prejudice." Moreover, it is argued from the cultural point of view that there can be no ranking of the so-called races of mankind in a hierarchical order, for "the truth is that all cultures have their successes and failings, their faults and virtues".

Individual or psychological differences, again, provide no justification for race prejudice, for "it seems unlikely that there are any inborn mental qualities which distinguish racial populations to the extent that stature does".

The general conclusion is that those who regard racial differences as important factors in producing human societies that are 'higher' or 'lower', 'better' or 'worse', are completely mistaken, and the hope is implicit in the papers presented in the book that their publication will play a significant part in Unesco's educational campaign. But if it is roundly asserted by Prof. Juan Comas (School of Mexican Anthropology) that "*there is no scientific basis whatever* for a general classification of races according to a scale of relative superiority", he also recognizes that "the notion of 'race' is so charged with emotional force that objective discussion of its significance in relation to social problems is uncommonly difficult". That is indeed true, as Unesco has found in the past when 'natural' rather than 'social' scientists have been asked to contribute to the discussion of this problem on the basis of their experiences as geneticists or zoologists. It is not the facts about human societies which constitute the difficulties that have to be faced so much as the emotions that have become associated with them. Unesco's campaign will have to be directed to the calming of human passions if its success is to be decisive. Scientific 'objectivity' cannot be achieved, it is now plain, by a frontal attack.

T. S. Simey

A FOSSIL MAMMAL-LIKE REPTILE

The Liassic Therapsid Oligokyphus

By Walter Georg Kühne. Pp. x+150+12 plates. (London: British Museum (Natural History), 1956.) 80*s*.

More than a hundred years ago Charles Moore, an amateur geologist of Bath, first showed that rocks of Rhaetic age were to be found in Britain. He followed them over the country, even up to the Moray Firth, and in the course of his work discovered that in the Mendips the Rhaetic rocks lay on the Carboniferous limestone, obviously essentially on a sea beach. At such places the limestone was eroded along joints forming fissures which passed out on the sea beach. In such fissures deposits of Rhaetic age contained teeth, very largely those of fish, but in some tons of infilling from a fissure at Holwell he found about twenty teeth, seen by Owen in 1858, and regarded by him as mammalian.

These teeth (with a tooth found under similar conditions in Württemberg) immediately appeared in all text-books of geology as much the earliest members of the group. But this wide recognition of the importance of these mammalian fossils did not encourage anyone to hunt for more in the original fissure, or in others in the neighbourhood.

Thus when, in 1938, an unknown young German called on me and said he was going to hunt for Triassic mammals, I was surprised and pleased to be told that he intended to follow Charles Moore's example, and to learn much later that he had done so successfully. But Kühne found another fissure which produced teeth and bones of *Tritylodon*, Owen's South African Triassic mammal, or a near ally. At this stage the War intervened and he was interned, and ultimately moved to the Isle of Man, where he used the equipment of the Port Erin Marine Biological laboratory to prepare his material at leisure. He had more than 2,000 specimens, broken but well preserved, representing almost every part of a small animal about as big as a rabbit. From this material he has now published the monograph which is the subject of the present review.

The animal is a close ally of Owen's *Tritylodon*, and the whole structure, except for hands and feet, is described in great detail. It proves to be, not a mammal, but the most advanced mammal-like reptile known. None the less it is of the greatest importance because it shows how far these animals may go in attaining a mammalian structure, even in a group which lived on long after real mammals had already come into existence. Comparison of it with earlier cynodonts, with living monotremes, and with Mesozoic mammals throws much light on the real nature of evolutionary progress.

Thus Dr. Kühne's excellent and very well illustrated monograph will be of great value to everyone who is concerned with the origin of mammals, or the nature of the evolutionary process.

D. M. S. Watson

PAVLOV, PSYCHOLOGY AND PSYCHIATRY

Ivan V. Pavlov

Toward a Scientific Psychology and Psychiatry. By Dr. Harry K. Wells. (Pavlov and Freud—1.) Pp. 224. (London: Lawrence and Wishart, Ltd., 1956.) 21*s*. net.

This is an enthusiastic account of Pavlov's contributions to psychology and psychiatry and of the development of his ideas in the Soviet Union. The author's sources, apart from Pavlov's own works, are limited to a few texts by Asratyan, Bykov and Ivanov-Smolensky. He epitomizes Pavlov's doctrines as generalizations relating to the function of the brain, speech, protective inhibition, the physical basis of mental illness, and sleep therapy.

Pavlov's task, we are told, was "to demonstrate experimentally once and for all, that the human soul is caused, that mental life is a function of highly organized matter in the form of the brain. This was a revolutionary task in every sense of the word, scientific, ideological, political and social". From this and other passages in which Lenin and Stalin are freely quoted it appears that Dr. Wells's admiration for Pavlov is spiced with political adulation. Thus he cites with approval Mr. Malenkov's warning against "remnants of bourgeois ideology, survivals of private property mentality and morality", and informs us that in the Soviet Union "capitalism has been shattered and Pavlovian science has triumphed . . .". Such intrusion of political sentiments into science will not enhance the value of the book for readers who feel that the two should be kept strictly apart. But Pavlov must not be discredited by the ardour of his biographers.

The wider issue raised by the book is whether a scientific psychology can be established on Pavlov's two presuppositions, first, that mental activity is a function of the brain, and second, that it reflects objective reality. Both of these, Dr. Wells asserts, are tested and proved features of Marxism.

No objection need be raised to the first principle, though we may prefer to regard the brain, with

Sherrington, as an "organ of liaison" with mind. The second principle, however, raises difficulties. Pavlov did not deny the existence of subjective states. Nor did he attempt to reduce them to nervous action. On the contrary he declared that "only one thing in life is of actual interest to us—our psychical experience", but its mechanism remains "wrapped in deep mystery". Psychical experience, he believed, can only be studied scientifically in terms of nervous activity. He denied that psychological phenomena may be studied directly. Indeed his conception of science rules this out.

The theory of conditioned reflexes relates, however, only to performance. What has it to tell us about the perception of form, our grasp of logical, linguistic or other mental structures, or about that most distinctive of human characteristics—understanding? A chimpanzee may be taught to use a typewriter and by chance, sooner or later, he may type a page of Shakespeare. But he would never understand what he had done. Pavlov's refusal to try to understand the mental patient's difficulties as they appear to him subjectively may explain a recent statement by Prof. Ivanov-Smolensky: "How hard," he said, "our psychiatrists find it to assimilate Pavlov's teaching."

Thus the choice that Pavlov offers to the psychologist is either to renounce the study of psychological phenomena or abandon Pavlov's conception of science.

JOHN COHEN

ANCIENT MAN

Finding Fossil Man

By Robin Place. Pp. 126+31 plates. (London: Rockliff Publishing Corporation, 1957.) 21*s*. net.

THIS book is intended primarily for secondary school pupils, as well as for students taking classes in further education. It is admirably suited to its purpose. Not only is it written in simple language and in an interesting manner but also the author is well qualified academically to undertake such a work.

Mankind in the animal setting is first discussed, and here the subject is lightened by a number of illustrations. The geological setting is next considered and there are interesting notes on what amphibians and early mammals contributed to man's bodily make-up. The earliest finds of true man then come under review, followed by an account of that queer sport of evolution—Neanderthal man. Then we come to the kind of man who could and has survived, the kind least specialized in its hard parts, *Homo sapiens*.

The work continues with an account of a number of well-known finds of human remains and how they were discovered. Finally, there is a chapter linking up prehistoric finds with the earliest civilizations.

Altogether the book is well worthy of study by heads of schools, whether grammar or secondary modern. In these days of more pay for less work it is high time we offered our children some interesting intellectual hobbies, which, should they attract, will be a joy to them throughout their lives. This book only deals with the foundations of the subject of man himself; we can hope that a sequel will continue the story of his early cultures, tools, and way of life.

M. C. BURKITT

NOXIOUS AND OBNOXIOUS INSECTS OF THE PACIFIC

History of Entomology in World War II

By Emory C. Cushing. Pp. vi+117+9 plates. (Washington, D.C.: Smithsonian Institution, 1957.) n.p.

Insects of Micronesia

Volume 12, Number 1. Diptera, Culicidae. By Richard M. Bohart. Pp. iv+85. (Honolulu: Bernice P. Bishop Museum, 1957.) 1.75 dollars.

THE first of these books is a popular account, not to be taken quite so seriously as its title suggests. It offers, however, some food for thought. In a fascinating introductory chapter we are presented with such curiosa as the primordial "ooze of a nebular universe", Hannibal "stymied in Syracuse", poetic alliteration, "by the inroads of malaria" and the modern Scythians and Peruvians who "still search for a living morsel of protein and vitamin in the head hairs of their young". Progress, it seems, pursues devious paths, a fact not always appreciated across the Atlantic. So it proves, for in the ensuing chapters we are treated to the spectacle of man endeavouring to exterminate himself while at the same time perfecting, under the spur of military exigency, drugs and insecticides which in a short time will save millions of lives. The tone throughout is eupeptic. Insecticide resistance, a post-war phenomenon in the medical field, is nowhere mentioned. "Many living Americans remember the day when the most expedient method of ridding the home of houseflies was for each member of the family to take a cloth and wave it frantically, converge on a convenient door, and with one concerted rush 'shoo' out the flies. That day is gone for ever." Is it? The price is still eternal vigilance.

It is perhaps unkind to both to couple the second work with the first, but they have a common origin in the enlightened and liberal attitude to entomological research adopted by the United States Armed Forces both during and after the Second World War. This is something which it is always a pleasure to acknowledge. Almost the whole of the available information about Micronesian mosquitoes has been published since 1938 and the bulk of it since 1945. Nor is the present monograph merely a review of past work. On the contrary, it contains much that is new and affords welcome evidence of continuing effort in the area concerned. As a specialist monograph it invites little criticism. The general discussions are interesting but savour a little of parochialism. Thus the point is well made that in most parts of the tropics container habitats are used more extensively than in the temperate zones. This is interesting and could well have been pursued further. It seems to be less true of continental Africa than other parts of the tropics, a point which might not be wholly devoid of practical significance since we are told that the predaceous African mosquito *Toxorhynchites brevipalpis* Theo. has recently been introduced into Truk and Guam in the hope that it will prey on other container breeders. There is news also of the (unpremeditated) introduction of an *Anopheles* breeding in ground pools from the Philippines into Guam, the first Micronesian record of this genus. This is a notable contribution to mosquito literature and should be in the possession of all who are interested in the group.

P. F. MATTINGLY

WORLD POPULATION*

By COLIN CLARK
Director, Agricultural Economics Research Institute, Oxford

IF not impeded, the probability of conception in fertile human couples appears to average 0·1 per menstrual cycle, higher for first conceptions, but otherwise irrespective of age. From a minimum of 3 per cent, the proportion of infertility rises rapidly with age from 25 onwards. Infertility, at any given age, appears greater among coloured than among white races. The assertion that natural human fertility rises with under-nourishment rests upon no evidence whatsoever.

This probability of conception, allowing for some miscarriages, and some temporary sterility during lactation, implies the birth of a child for every $2\frac{1}{2}$ years of married life, as observed in England a century ago, or in some peasant communities now.

'Total fertility', defined as the number of children born to an average woman by the end of her reproductive period, in the circumstances most favourable for reproduction, when every woman marries young, and with surplus males waiting to re-marry any widows, assuming the onset of infertility on the average twenty years after marriage, should be 8 (that is to say, $20/2\frac{1}{2}$). This rate is indeed found among those (very few) Irish women who are married young, to young husbands, and who are not widowed; rates of 6 or 7 are found among primitive nomadic peoples, and among peasant populations in Asia and Latin America; considerably lower figures are found in Africa, where the percentage of infertility is unaccountably high. The highest total fertility ever recorded was 10, for the early French-Canadian settlers; but they were a group specially selected for vigour and hardihood. Evidence from India indicates that the consummation of marriage below the age of seventeen tends, in the long run, to reduce rather than to increase total fertility.

Writing in 1798, Malthus taught that populations always tend to increase up to the limits of their food-producing capacity, whereupon population growth must necessarily be checked, if not by late marriage (which he recommended) then either by 'misery' or by 'vice'. In the same year Jenner was publishing his proposals for vaccination against smallpox, which probably did more than any other single factor to bring about the great rise in population in the nineteenth century. Malthus, however, stated that Jenner's work was a waste of time, because the "principles of population" indicated that, even if he were successful, it was inevitable that some other disease would spring up to take the place of smallpox. Instances of populations growing rapidly until they reach the limits of food supply have occurred, but exceptionally, and certainly not generally in the history of mankind.

For the greatest proportion of mankind's time upon Earth our ancestors lived the life of nomadic hunting peoples, which involves high mortality, with few people surviving to the age of forty. In these circumstances, a total fertility of 6 or 8 will only just suffice to maintain the population. This is observed among some primitive tribes to-day. The present world average rate of population increase is $1\frac{1}{2}$ per cent per annum, as against 1 per cent in the nineteenth century. From approximate figures of world population (errors in them will not affect the order of magnitude of our results) we deduce, between the first and the seventeenth centuries A.D., an average growth-rate of only 0·05 per cent per annum; and from the beginning of the human race to the beginning of the Christian era 0·005 per cent per annum. These low growth-rates, while populations were far smaller than those now supported by the same agricultural methods in the same areas, were clearly not due to the world's inability to produce food.

In a settled peasant community, population increases at the rate of about $\frac{1}{4}$ per cent per annum, but only so long as there are no widespread epidemics, and peace and order can be preserved. "Better fifty years of Europe than a cycle of Cathay"; India and China for thousands of years have been slowly building up population, and then losing most of it again in recurring periods of war and disorder. In Europe, where total fertility may have been reduced to 5 by the custom of later marriage, population growth proved to be slow, too. The Black Death was only the first of a cycle of epidemics which checked the growth of population all over Europe. In France, which also suffered greatly from the Hundred Years' War, the population-level of the fourteenth century was not regained until the eighteenth. Egypt, and many other regions in the Middle East, had less population in the nineteenth century than they had had 2,000 years earlier. The spread of malaria, sometimes adduced as a cause, is better regarded as a consequence of social disorder; *Anopheles* only secures a hold when irrigation channels are neglected. Sustained growth of population, at the rate of 1 per cent per annum or more, which began in the British Isles and Scandinavia with the improvement of medical knowledge in the late eighteenth century, began in China only with the establishment of peace under the Manchu Empire in the seventeenth century, in India with the establishment of the British Empire, in Latin America not until the nineteenth century, and in Africa not until the present century.

Prospects did not look good at the time when Malthus wrote. Real wages were low and did not rise until the middle of the nineteenth century. Nevertheless, the British courageously refused to listen to Malthus. Had they done so, Britain would have remained a small eighteenth-century-type agrarian community; and the United States and the British Commonwealth would never have developed. No great degree of industrialization would have been possible. The economics of large-scale industry demand large markets and a first-class transportation system, only obtainable with a large and growing population.

The country which did listen to Malthus was France, where size of family began to decline early in the nineteenth century. "If population limitation were the key to economic progress," as Prof. Sauvy said at the World Population Conference, "then France should be the wealthiest country in the world by now." France, which seemed to be on the point of dominating the world in 1798, has since seen her influence steadily decline; and the recurring inflations which France has suffered are an economic consequence of the excessive burden of pensions and other overhead costs which an ageing country has to carry.

* Based on the Newmarch Lectures given in University College, London, during February 1958.

When we look at the British in the seventeenth and eighteenth centuries, at the Greeks in the sixth century B.C., the Dutch in the seventeenth century, and the Japanese in the nineteenth century, we must conclude that the pressure of population upon limited agricultural resources provides a painful but ultimately beneficial stimulus, provoking unenterprising agrarian communities into greater efforts in the fields of industry, commerce, political leadership, colonization, science, and (sometimes but not always, judging from Victorian England) the arts.

But if a country fails to meet the challenge of population increase, it sinks into the condition known to economists as 'disguised unemployment' or rural overpopulation. The simpler forms of agriculture, using hand tools (as in China or Africa), can economically occupy 50 able-bodied men per sq. km. (246 acres), or 20 men per sq. km. using draught animals. A man working for a full year, using hand tools, produces at least two tons of grain-equivalent (expressing other products as grain at their local exchange values); twice that with draught animals. Minimum subsistence requirements can be estimated at 275 kilos of grain-equivalent per person per year (225 kilos of grain plus a few other foods and textile fibres). So one agricultural worker, even with hand tools, can produce subsistence for seven or eight people, that is to say, he can feed himself and his dependants at better than subsistence-level, and have some food to exchange for clothing, household goods, etc., so that an urban population can begin to grow up. (One Canadian grain grower, however, could feed 750 at subsistence-level.) Where, however, the densities of agricultural population exceed these limits, as in southern Italy, India, Egypt, etc., the marginal product of this additional labour is very low, and the consequence is that many men consume only a subsistence diet, are idle for a considerable part of their time, and have little surplus to exchange for industrial products.

Lord Boyd-Orr's statement that "a life-time of malnutrition and actual hunger is the lot of at least two-thirds of mankind" is simply an arithmetical error, based on confusing two columns in a statistical table. Malnutrition exists in the world, but it is impossible to state its extent until physiologists can be more precise about food requirements, and statisticians about agricultural output and body-weights.

Countries the population of which has outrun their agricultural resources can industrialize, and exchange manufactures for imported food, as did Britain and Japan, and as India can—if they have a large population and a good transport system. Experience in both India and the U.S.S.R. has shown that, with modern engineering knowledge, capital requirements for establishing an industrial community are less than was previously supposed. This solution, however, is not open to the smaller and more isolated islands, away from the main channels of world trade. If they become overcrowded they must seek relief in emigration, which from an island such as Porto Rico is as high as 2 per cent of the population per annum.

Some fear, however, that the agricultural resources of the world as a whole may soon be exhausted. The world's total land area (excluding ice and tundra) is 123 million sq. km., from which we exclude most of the 42½ million sq. km. of steppe or arid lands, discount anything up to half the area of certain cold or subhumid lands, but could double 10 million sq. km. of tropical land capable of bearing two crops per year. We conclude that the world possesses the equivalent of 77 million sq. km. of good temperate agricultural land. We may take as our standard that of the most productive farmers in Europe, the Dutch, who feed 385 people (at Dutch standards of diet, which give them one of the best health records in the world) per sq. km. of farm land, or 365 if we allow for the land required to produce their timber (in the most economic manner, in warm climates—pulp requirements can be obtained from sugar cane waste). Applying these standards throughout the world, as they could be with adequate skill and use of fertilizers, we find the world capable of supporting 28 billion people, or ten times its present population. This leaves us a very ample margin for land which we wish to set aside for recreation or other purposes. Even these high Dutch standards of productivity are improving at a rate of 2 per cent per annum. In the very distant future, if our descendants outrun the food-producing capacity of the Earth, and of the sea, they will by that time be sufficiently skilled and wealthy to build themselves artificial satellites to live on.

'Total fertility' is an accurate measure of reproductivity, but we cannot measure it directly until the generation in question has reached the end of its reproductive period. In interpreting current data, a difficult mathematical problem is involved, because the probability of any given family producing a child depends upon: (1) the mother's age, (2) the duration of the marriage, (3) the number of children already born; and these three variables are highly intercorrelated. Crude measurements, such as birth-rates and reproduction-rates (so-called), can give gravely misleading results when there have been temporary fluctuations in the marriage-rate, or in the age-structure of the population. Henry has devised an elegant mathematical technique whereby, from the birth data of a single year, it is possible to integrate the probabilities for all future years that a family containing n children will expand to $(n + 1)$. By multiplying together these probabilities the ultimate total fertility of the generation can then be estimated.

During the past century reproductivity has fallen heavily in all the economically advanced countries. During the past two decades, however, there has been a dramatic reversal of this trend in several countries, particularly in France, and in the United States and the British Commonwealth countries, the populations of which are now growing faster than India's; but not in England. Mortality-rates throughout the world, after declining fairly steadily for a century, greatly accelerated their fall in the 1930's and 1940's, through the discoveries of sulpha-drugs and penicillin. We must therefore certainly expect a further acceleration in the rate of growth of world population.

We have as yet little understanding of the economic, social, historical and religious factors lying behind either the past decline in fertility, or its recent recovery. Most familiar generalizations have proved to be erroneous. It used to be held that it was the wealthier, more educated and more urbanized communities which most reduced their fertility. This was true in the past; but in the English-speaking and Scandinavian countries the educated are now beginning to have larger families than the uneducated. The urban-rural difference in reproductivity disappeared in France fifty years ago, and is now disappearing in Britain and the United States. We have little understanding of those profound motives which make people willing to face the hardships and inconveniences of bringing up a family, motives often of a religious or similar character. An irreligious community is rarely a reproductive one.

THE TRANSITION FROM THE IONOSPHERE TO INTERPLANETARY SPACE

DURING the past decade there has been a revival of interest in the problems of the outer corona (commonly called the zodiacal light region) and in the study of the outer ionosphere. For the ionosphere this interest has been increased by three factors. The original work of L. R. O. Storey on whistling atmospherics has been developed to give reasonably reliable values of electron density at distances of up to four Earth radii from the Earth. It is now possible to obtain strong radio reflexions from the Moon, giving information about the electron content of the upper ionosphere. Lastly, observation of the radio emission from artificial Earth satellites is likely to provide data concerning electron density and irregularities above the $F2$ peak of the ionosphere.

These matters formed the subject of a Geophysical Discussion held in the rooms of the Royal Astronomical Society at Burlington House on February 21 under the chairmanship of Mr. J. A. Ratcliffe (Cambridge). The discussion was initiated by five short talks by astrophysicists and ionospheric physicists.

Prof. Sydney Chapman began by describing his model of the complete solar corona, extending from 0·06 solar radii above the solar photosphere to the boundaries of the known solar system at 40 A.U. (astron. units) or $8{\cdot}6 \times 10^3$ solar radii. This is a static model consisting solely of ionized hydrogen in which there is a constant outward flow of heat by thermal conduction. The thermal conductivity of this gas can be calculated with reasonable accuracy from kinetic theory considerations, assuming no appreciable magnetic field. Taking the value of the electron density in the corona at 1·06 solar radii from eclipse measurements, and assuming a temperature in this region of about 10^6 deg. K., both the temperature and the electron density can be calculated as a function of distance from the Sun. According to this theory the electron density at large distances is remarkably sensitive to the assumed temperature at the base of the corona. At 1 A.U. it changes from 3×10^3 cm.$^{-3}$ to 4×10^2 cm.$^{-3}$ for an increase in the assumed temperature at 1·06 solar radii from $1{\cdot}0 \times 10^6$ deg. K. to $1{\cdot}2 \times 10^6$ deg. K. The calculated temperature is $2{\cdot}2 \times 10^5$ deg. at 1 A.U. and $7{\cdot}7 \times 10^4$ deg. at 40 A.U. The calculated electron density values are in good agreement with the current eclipse values (which extend to 20 solar radii) and with the generally assumed values in the zodiacal light region. As the thermal conductivity of an ionized gas depends upon the magnetic field in the gas, these deduced values of electron density and temperature may be seriously affected by interplanetary fields of solar origin, although the good agreement with eclipse models to 20 solar radii shows that such fields may be unimportant for the model. However, Prof. Chapman emphasized that his model is no more than a preliminary idealized static model, and in a real corona there are undoubtedly other mechanisms operating, particularly corpuscular emission from the Sun. An important feature of this theory is that as the Earth may be imagined as a cool body passing through a hot gas, there is a ready explanation for the supposed downward flux of heat through the $F2$-layer.

The problem of the determination of electron density in interplanetary space by observation of the zodiacal light was discussed by Dr. D. E. Blackwell (Cambridge). The zodiacal light is seen in tropical regions as a cone of light standing above the western horizon after sunset, or the eastern horizon before sunrise. Its observation is peculiarly difficult, and the interpretation of the data is uncertain. The phenomenon is caused by the scattering of sunlight by interplanetary material, and its brightness at each place in the sky is the sum of contributions from scattering elements along the line of sight through the solar system. The active scattering material is now supposed to be partly dust and partly free electrons, and the first big problem is to decide the relative contributions of dust and electrons, and to determine electron densities. The only method of separation that has been tried so far has used observations of polarization. The polarization of the electron component can be calculated and that of the dust is assumed to be zero. Knowing the total polarization, the relative proportions of dust and electron components can be calculated. This method gives for the electron density at about 1 A.U. from the Earth a value of about 600 cm.$^{-3}$, which is in apparent agreement with values obtained from whistling atmospherics by Storey and others. However, acceptance of this value leads to difficulties. One is that the plane of symmetry of the electron component is very close to the ecliptic, which has gravitational significance only. Another is that it leads to two subsidiary conditions, one of which must be accepted. Either there is a sharp cut-off of electron density near 1 A.U. (corresponding to a sharp diminution of ionization) or else the polarization of the dust component is negative. Neither condition is welcome, and the simplest way out of the difficulty is to suppose that the electron component does not exist.

The information obtainable from the study of radio echoes from the Moon was discussed by Dr. J. V. Evans. Considering the propagation of a plane polarized wave through the ionosphere, the plane of polarization of the received wave is rotated by an amount proportional to

$$\frac{1}{f^2} \int_0^R N_e . B\cos\theta \sec\chi . dh$$

where N_e is the electron density, $B\cos\theta$ the component of the Earth's magnetic field along the ray path, χ the zenith angle, and f the frequency of the wave. To obtain the number of complete revolutions of the plane of polarization it is necessary to observe simultaneously at two frequencies, those used by Evans and his collaborators being 119·28 Mc./s. and 120·72 Mc./s. Measurements of the total rotation can be used to check an ionospheric model. In such a model, most of the rotation occurs below a height

of 600 km. because the function $B\cos\theta \sec\chi$ decreases rapidly beyond this height. If an average value for $B\cos\theta \sec\chi$ is used up to a height of 600 km., the observed rotation gives the total electron content of the ionosphere. Results obtained over a period of a year suggest that the number of electrons above the *F*2-region, at a height of about 350 km., is about three times as great as the number below. The rotation produced by the ionosphere is variable and it would be very difficult to measure the small residual rotation produced by the electrons between the Moon and the ionosphere. It is suggested that a comparison of the total electron content deduced from Moon-echo work with that deduced from observation of an artificial Earth satellite might give this density.

Dr. K. Weekes (Cambridge) discussed the deductions about the outer ionosphere that may be made from observations of artificial Earth satellites. One clear application is to the study of irregularities in the ionosphere. A study of the fluctuations of the signal from the first Russian satellite ($1957\alpha_1$) showed that the bottom of the irregular zone is at a height of 280 km. More precise knowledge can be expected to follow from three kinds of measurement. These are, the Doppler effect, the Faraday effect or the rotation of the plane of polarization, and the angle of arrival of the radio signal. The first effect depends upon the refractive index of the medium, but is independent of the Earth's magnetic field. The second effect depends upon the magnetic field. The Doppler effect and the angle of arrival are closely related and give the same information unless very accurate measures are available, when it should be possible to deduce the electron density at the satellite. Such a deduction requires a measurement of the Doppler shift to 0·5 c./s. and the angle of arrival to 1 min. of arc; observations of Satellite $1957\alpha_1$ were too inaccurate to permit such deductions. The Faraday effect can be separated from effects of rotation of the satellite by observing nearly simultaneously on two frequencies, because the rotation effect should be independent of frequency, whereas the Faraday effect varies inversely as the square of the frequency. It is usually very difficult to separate the effects because of scintillation, but data from the few good records available are consistent with the known ionosphere and show that the electron density falls off rather slowly above the *F*2-layer.

Some recent American work on audio-frequency atmospherics, particularly that of Helliwell at Stanford and Gallet at the U.S. Bureau of Standards, was summarized by Mr. J. A. Ratcliffe. These atmospherics were first thoroughly investigated by Storey at Cambridge, who showed that each burst is propagated along a line of force of the Earth's magnetic field, the musical note resulting from dispersion in the ionosphere. This theory requires the electron density at a distance of 3 Earth radii to be about 300 cm.$^{-3}$. Since Storey's pioneering work, the time variation of frequency of the received atmospheric has been studied towards higher frequencies, and it has been found possible to deduce from the shape of the curve the magnetic field at the maximum height of the line of force. As may be expected, this maximum height depends upon the geomagnetic latitude of the source of the atmospherics, the greatest height being reached for those lines of force beginning and ending in high latitudes. This maximum height is about 4 Earth radii. However, more recent work has shown that some whistlers are multiple, which suggests that the Earth's magnetic field is not the sole guiding factor. It is possible that the multiple effect is due to a streaky ionosphere, the waves being to some extent guided by filamentary structures which are roughly aligned along the lines of force.

There is also a second type of naturally occurring audio-frequency atmospheric which is characterized by a different variation of frequency with time, showing a minimum frequency. It has been suggested that this type of atmospheric is excited in the ionosphere by corpuscular radiation from the Sun. For this mechanism to operate, the corpuscular velocity at the Earth must be of the order of 10^4 km. sec.$^{-1}$, which means that the particles are probably accelerated near the Earth.

At this stage the chairman invited discussion of these topics. Dr. A. Hewish described the Cambridge work on the occultation of radio sources by the solar corona. Scattering of the incident radio wave by irregularities in the corona can be observed to a distance of 20 solar radii. Such irregularities are difficult to explain unless the general magnetic field of the Sun extends to distances at least as great as this, and consequently the thermal conductivity may be appreciably smaller than that assumed by Prof. Chapman. An elementary consideration of rotational stability suggests that such a field could not extend to distances greater than about 40 solar radii if it is of a dipole character.

Dr. R. d'E. Atkinson (Royal Observatory) thought that a corona of the Chapman type would considerably damp the orbital motion of the Earth, but Prof. Chapman again emphasized that his is a very idealized model and undoubtedly the real corona is far more complex.

Prof. C. W. Allen (University College, London) suggested that the solar magnetic field a few radii from the Sun is directed towards the Earth. If this is correct, the Chapman theory is not substantially changed by the inclusion of an interplanetary magnetic field. Prof. V. C. A. Ferraro agreed with Prof. Allen on this point.

Mr. Ratcliffe stressed the apparent disagreement between the optical results, which suggest a very small electron density, and the whistler results, which suggest a density between 600 and 1,000 cm.$^{-3}$. He asked if the Chapman theory predicts an annual variation in the ionosphere due to the variation of the distance of the Sun.

In reply, Dr. Blackwell said that the apparent disagreement between the radio and optical results may only be due to an unexpectedly great extension of the Earth's atmosphere. Recent Russian observations of the enhancement of the 5577 OI atmospheric emission line in the zodiacal light support this theory.

Prof. Chapman could not say definitely whether or not the changing distance of the Sun would have an effect on the ionosphere. He thought that acceptance of his theory does not depend upon the zodiacal light measures of electron density.

Prof. Allen thought there was little essential difference between the static corona of Chapman and dynamic theories. Dr. R. A. Lyttleton (Cambridge) considered that the sudden disruption of comet tails indicated the presence of interplanetary gas.

This discussion has demonstrated that important results may be expected to follow from a combination of astronomical and ionospheric techniques.

D. E. Blackwell

DANGERS OF THE ATOMIC ARMS RACE

SECOND PUGWASH CONFERENCE

DURING March 31–April 11 an international conference of scientists was held at Lac Beauport, Quebec, to discuss the dangers resulting from the present atomic arms race, and means of diminishing them.

The conference was made possible by the generous hospitality and assistance of Mr. and Mrs. Cyrus Eaton, and it originated in the following way. In 1955, a public statement was issued by Earl Russell, Albert Einstein, and nine other scientists, directing attention to the dangers which had arisen as a result of the development of weapons of mass destruction, and calling for a meeting of scientists which would make a true and independent assessment of the hazards. A meeting for this purpose was held in Pugwash, Nova Scotia, in July 1957 which was attended by twenty-two scientists. That meeting published a statement concerning the dangers arising from test-explosions of nuclear weapons and the consequences which would arise from their use in warfare; the problems of control of nuclear weapons; and the responsibilities of scientists.

The meeting at Pugwash set up a Continuing Committee, of which Earl Russell was the chairman, and Prof. C. F. Powell, Prof. J. Rotblat, Prof. E. Rabinowitch and Academician D. F. Skobeltzyn were members. The Committee was instructed to call further meetings, should they appear desirable.

Since the meeting in Pugwash, there has been a further intensification of the arms race. At a meeting of the Continuing Committee in London in December last, it was decided to call the present Conference. All the scientists invited warmly supported the objectives of the meeting, although some were unable to attend.

In calling the present Conference, the aim was to provide an opportunity for private discussion, in which there could be a frank and friendly exchange of views on the many difficult issues which stand in the way of a general settlement among the Powers and the establishment of a lasting peace.

Most of the discussions of the Conference were grouped under three main headings: the dangers of the present situation; means of diminishing the immediate dangers; and means of relaxing tension. The topics discussed included: dangers of wars arising from technological accidents or as a result of conflicts between small nations; the biological hazards consequent on fall-out; the problems arising from the possibility of the acquisition of nuclear weapons by additional nations; problems posed by the development of long-range rockets; problems of bases on foreign territory; problems of large conventional forces; the political and technological aspects of a ban on tests; the problems of general political and military stabilization; short- and long-term policies aimed at establishing peace; the co-operation between nations in joint projects of a constructive nature; exchange of students and scientists; and measures for promoting international trust.

The Conference showed that in spite of different approaches to particular problems, there was a common agreement on the nature and magnitude of the grave dangers of our present situation, and a common desire to contribute to their removal by bringing about lasting peace through political settlements, and ultimately through far-reaching disarmament. The friendly atmosphere of the meeting, and a sense of common purpose, contributed greatly to the usefulness of the discussion.

Even in a short conference, it was found possible to make a serious appraisal of some of the decisive problems of our times. In a period of technological and scientific advance of unprecedented speed, it is believed that scientists have a special responsibility and a special competence to promote informed opinion. With this aim in mind, the materials of this Conference will be made available to interested governments. It is not intended, however, at this time to publish the details of the discussions and conclusions. Rather, each of those present will seek to present the results of the Conference to scientists and others who may be interested.

The Conference recognizes the need to hold further meetings, some of which may differ from the present one in the number of participants and in general type. It favours the plan presented by the Continuing Committee to hold another conference in September, probably in Austria, which will be more broadly representative and with a larger number of participants. In addition to discussing the findings of the present Conference, the next meeting will deal with the long-term problem, "Peace in the Atomic Age".

The following were present at the recent meeting:

Prof. M. L. Oliphant, Australia;
Prof. Cyrias Ouellet, Canada;
Sir Robert Watson-Watt, Canada;
Prof. Chou Pei Yuan, People's Republic of China;
Prof. Bernard Gregory, France;
Prof. C. F. von Weizsäcker, Germany;
Sir Charles Darwin, Great Britain;
Prof. C. F. Powell, Great Britain;
Prof. J. Rotblat, Great Britain;
Prof. C. H. Waddington, Great Britain;
Prof. A. M. Kuzin, Soviet Union;
Academician D. F. Skobeltzyn, Soviet Union;
Academician A. V. Topchiev, Soviet Union;
Academician A. P. Vinogradov, Soviet Union;
Prof. John Edsall, United States;
Prof. Morton Grodzins, United States;
Mr. William A. Higinbotham, United States;
Col. Richard S. Leghorn, United States;
Prof. Linus Pauling, United States;
Prof. Eugene Rabinowitch, United States;
Prof. Leo Szilard, United States;
Prof. Jerome B. Wiesner, United States.

OBITUARIES

Mr. J. R. Womersley

John Ronald Womersley was born on June 20, 1907, at Morley, in Yorkshire. He studied at the Imperial College of Science and Technology, London, and was awarded a first class in mathematics in 1928. After some further study there he took a post at the Shirley Institute (British Cotton Industry Research Association, Manchester), where he learnt to be a statistician. In 1937 he joined the Scientific Civil Service, moving to the Armament Research Department, Woolwich, and during 1942–45 he was head of the Ministry of Supply Advisory Service on Statistical Methods. At the end of the War the National Physical Laboratory set up its Mathematics Division, and Womersley was appointed to be its first superintendent. This post he held until 1950, when he took up duty as chief mathematician for the British Tabulating Machine Co. at Letchworth. The post came to an end in 1954, and after doing some work for the Medical Research Council he went to America for duties as a mathematician at Wright Field, Dayton, Ohio, under the American Air Force. He underwent a serious operation last year, but made an incomplete recovery and died on March 7. He leaves a widow and three daughters.

The general impression that Womersley gave was his sense of adventure in all the work he was doing. He was always looking for something new to undertake, sometimes be it said a little at the expense of the actual work in hand. I really only saw the fringe of his work during the War, but he seemed to impart a most refreshing breadth of outlook into what might have been just a dull routine. Thus, the chemists had never succeeded in making their propellants to beyond a certain limit of accuracy which he had evaluated, and there seemed no prospect of improving the manufacture. He was not content to leave the matter at that, but started to study whether the gun that was to use this propellant matched it in accuracy; for it might well be that for some parts of it a useless and expensive excess of accuracy had been demanded.

When the Mathematics Division at Teddington was set up at the end of the War, Womersley was selected from among a strong field to be its first superintendent. The starting of a new institution was exactly the thing he was good at. The general programme for it had, of course, been laid down by the committee which had recommended its establishment, but within these rather broad limits he got it going quite admirably, collecting a strong staff, and giving them the right types of work to do. One of the chief tasks of the Division was to initiate the development of an electronic computing machine. This he named the ACE (for Automatic Computing Engine—the word Engine being borrowed from Babbage's name for it a century before), and he and his staff took an active part in starting it; and though, of course, the actual construction fell chiefly to the electrical engineers, they were ably assisted in this work by several of his mathematicians. After a few years, however, when the Division was running smoothly, he became restless and accepted the invitation of the Tabulating Machine Co., and there spent some years developing their instruments, including a small electronic computer for business use.

This, too, ultimately did not satisfy him. The post came to an end, and while he was waiting for the position he was going to have in America, he went back to doing mathematics himself, a thing he had scarcely had time for during the years when he had been kept busy supervising the work of others. He made a study of the hydrodynamical problem of the flow of liquid through an elastic tube, with the view of understanding the way that the blood flows in the arteries. He had very good success in this problem, and it is a tribute to his general ability that he could revert to such a different kind of work after so long an interval. In 1955 he took up duty in a responsible post as mathematician at Wright Field, but even then he continued his work on blood-flow, and his last published paper was a report on this subject for the aero-medical branch of the U.S. Air Force.

We must grieve at the loss of a very able man, whose intellectual adventures had already carried him far over the fields available to a mathematician. It is idle now to speculate how much farther he would have gone if he had been granted the normal span of human life.

C. G. Darwin

Dr. A. F. S. Kent

Albert Frank Stanley Kent died on March 30. He was born on March 26, 1863, and so was one of the small band of scientists who have lived to more than ninety years of age. He was educated at Magdalen College School and was a member of Magdalen College, Oxford, taking his degree in the Honours School of Natural Science in 1886. He demonstrated in physiology at Owens College and the University of Manchester during 1887–89, in the University of Oxford during 1889–91, and at St. Thomas's Hospital, London, during 1891–95. In 1899 he was appointed the first professor of physiology at University College, Bristol, which became the University of Bristol in 1909.

Stanley Kent is best known for his work on the conduction of the mammalian heart beat, which he commenced under Gotch in Oxford. The atrioventricular bundle was investigated simultaneously by himself and in Leipzig by W. His, publications by both of them appearing in 1893. Although Kent gave his first communication on the subject to the Physiological Society in November 1892, it is clear that both share the credit for the discovery. In a series of communications, Kent described in detail the muscular links between atria and ventricles in mammals and the peculiar histological appearance of the cells found in them. He demonstrated the close anatomical connexion between these cells and the ventricular muscle fibres, and was able to show that atrial contractions can be made to follow artificially induced ventricular beats, though such reversed transmission through the bundle was impossible under strong vagal stimulation. The investigation of the bundle and its properties forms the basis of our knowledge of the normal conduction of the heart beat and of the functional dissociation of ventricles from atria which occurs in heart-block.

In 1914 Kent described also a subsidiary atrio-ventricular connexion on the right side of the heart,

the exact functional significance of which is still disputed.

He was elected a member of the Physiological Society in 1887, and since 1952 had been the Society's senior member, succeeding in that capacity another nonagenarian, Sir Charles Sherrington.

Kent's drive and powers of organization were made use of in various ways. He was an early worker on X-rays and helped to develop the Radiological Department at St. Thomas's Hospital towards the end of the past century. In Bristol he founded and carried on in University College a clinical and bacteriological research laboratory, which later became the City's public health laboratory; he was also for a time bacteriologist to the Royal Infirmary and lectured on this subject in the Medical School. He was one of the leading spirits in the campaign for the formation of a University which started in University College in 1900, and nine years later, owing in no small measure to his enthusiasm, the University was founded. In it he designed a new Department of Physiology, the nucleus of the present Department.

During the First World War, Kent became interested in problems of industrial fatigue and was responsible for various Government publications on the subject. In 1918 he resigned from his chair at Bristol to organize and direct a Department of Industrial Administration at the Manchester Municipal Technical College. After his retirement he returned to live in the West Country, converting one of the rooms in his house into a laboratory, where he eagerly continued his histological work on the heart, and he left behind him several thousands of sections representing the work of many years. His keen interest in physiological matters was retained until within a year or so of his death, when serious ill-health overtook him; this, his practical wisdom and his friendliness were his most striking characteristics.

R. J. Brocklehurst

Prof. H. S. Langfeld

Psychologists in Great Britain have reason to be grateful to the late Prof. Herbert Sidney Langfeld for much more than the three highly successful textbooks of which he was an editor. Some will know him as the author of one of the few truly psychological works on æsthetics which was, perhaps, a natural development from his earlier research on vision, bodily movement and synæsthesia and his interest in art—he had a fine collection of wood-engravings. Many more owe him a debt for his untiring work during the years he was secretary of the committee under the auspices of which the triennial international congresses of psychology are held. None could have filled this office better than he, and although he remained characteristically in the background, his efforts have been an important factor in securing international recognition of psychology as an experimental scientific discipline.

Langfeld was born on July 24, 1879, at Philadelphia, and educated at the Central High School there and at Haverford College. In 1902 he went as a member of the U.S. Diplomatic Service to Berlin, and stayed on there to take his doctorate of philosophy at the University under Carl Stumpf in 1909. He became a member of the staff at Harvard in the following year, and from 1924 to 1947, when he retired, was professor of psychology and director of the Psychological Laboratory at Princeton. He was president of the American Psychological Association in 1930, editor of the *Psychological Review* during 1934–47, a fellow of the New York Academy of Sciences, a member of the Pontifical Academy of Sciences, and permanent secretary of the International Congress of Psychology. He died in Princeton on February 25.

Proud of his German degree and of his European contacts, he and his wife were frequent visitors to Great Britain and the Continent, and their genuinely international sympathies brought them a wide circle of friends in many countries. They were generous hosts in their beautiful home on the outskirts of Princeton, where colleagues, graduate students from his department and visitors from overseas could relax.

Only those who have had the good fortune to work in his laboratory can appreciate fully his qualities as a departmental chairman. Jealous for the honour of psychology as a science, for his department and for his distinguished staff, but entirely without self-seeking, he devoted himself to creating conditions in which all those in the laboratory could develop their work fully and with enjoyment. His clean, spare figure and somewhat austere expression betokened a firm directness and integrity which earned respect. Yet his quick, almost boyish, smile brought immediate realization that even his most devastatingly frank comments were made with kindness and human feeling. The trust that everyone gave him was never betrayed, and the 'Langie' that he was called behind his back was a term of genuine affection.

A. T. Welford

Mr. S. Hazzledine Warren

The science of geology in Britain has always owed much to a strong body of highly competent amateurs. This applies particularly to the field of Quaternary geology, where the interests of the archæologist and geologist so usefully meet and interact. Like the late Arthur Bulleid, discoverer of the Glastonbury and Meare lake villages, Samuel Hazzledine Warren, who died on March 27 at the age of eighty-five, was first and foremost a geologist; and although he achieved remarkable distinction in the field of archæology, he did so very largely by applying the precise and cautious methods of the geological scientist.

He received no specific university training for either archæology or geology, and indeed began life as a business man; but he found this so little to his taste that he deliberately gave it up in favour of a life of patient and rewarding investigation. Thus he spent sixty happy years of research, a large part of them gladdened by the companionship of his wife who accompanied him, in his elaborately fitted expedition car, with his dog 'Silex'.

He concentrated the greater part of his research in south-east England, that sensitive region upon the margin of the maximal advances of two glaciations, and rich indeed were his rewards. His name is particularly associated with investigation of the interglacial deposits at Clacton-on-Sea, where he established the presence of a Palæolithic industry of flint flakes and chopper-cores since widely recognized in other parts of the world. It was typical that he took great trouble to secure careful identification of the rich flora and fauna by reference to suitable experts, and equally typical that when, thirty years later, the techniques of pollen analysis had been developed, he lost no time in securing that technique to supplement

the findings already made. In this manner it was eventually shown that the Clactonian belonged to the Great Interglacial, and this confirmed the great antiquity of the charred wooden spear that he had discovered at this site, the oldest known wooden artefact in the world.

During the first two decades of the present century the industrial exploitation of the Lea Valley exposed numerous sections in the valley gravels, and Hazzledine Warren showed industry, caution and skill in investigating and recording these deposits, notably the so-called 'Arctic Plant Beds' of the Ponder's End stage, and afterwards the Late-glacial deposits exposed at Nazeing.

Other important discoveries included a Neolithic axe factory at Graig-lwyd in North Wales, and the recognition of the submerged 'Lyonesse' land surface on the Essex coast with its very rich archæological remains.

The quality of scientific acumen seems to be born with some men, as it certainly was with Hazzledine Warren, and it was a great pleasure sometimes to see with what percipience he could correct on occasion his professional colleagues (myself not excluded). Hazzledine Warren's distinction was happily recognized by his election to the presidency of the Geologists' Association and of the Essex Field Club, by honorary membership of the Prehistoric Society, and perhaps most notably by the award of the Prestwich Medal of the Geological Society of London and the Henry Stopes Medal of the Geologists' Association.

H. Godwin

NEWS and VIEWS

New Foreign Members of the Royal Society

The following have been elected foreign members of the Royal Society: André Lwoff (Paris), distinguished for his work on the morphology and nutritional requirements of protozoa, and for his researches on lysogenic bacteria and bacteriophage; Nikolai Semenov (Moscow), distinguished for his work in chemical kinetics, especially for his pioneer work on chain reactions; George Gaylord Simpson (New York), distinguished for his contributions to palæontology and evolution; and Arthur Stoll (Basle), distinguished for his work on the chemistry of natural products.

Botany at Queen Mary College, London: Prof. F. M. Haines

Frederick Merlin Haines, who retires from the chair of botany at Queen Mary College, London, at the end of the present session, took over from the late Prof. F. E. Fritsch, whose reader, physiologist and former student he had been, in 1949. No other botany department in the University of London has formed a unit in quite the way which that at Queen Mary College has done under Haines. The nearest approach would perhaps be found in the older universities, where it is a rule seldom broken that all the staff come from the same department, a state of affairs which fosters mutual understanding and maintains a distinctive tradition. Only Fritsch, however, was able to bring this about in London; that he did so and that Haines was secured as his successor is something for which the department and indeed the University may well be profoundly grateful.

Haines's botanical interests have been mainly concentrated on the water relations of plants, on which he has published many papers and given more or less biennially the intercollegiate lectures for many years. He has, however, wide interests outside the field of botany. As chemist, physicist, engineer and general handyman, he is as good at the bench as in the study, and apparatus of all kinds, from thermostatic controls to clocks and tape recorders, flow ceaselessly from his workshop at his home in Kent. He is a gifted painter, spending much of his holidays with an ancient car in search of landscapes: his recent book, "Tone and Colour in Landscape Painting", embodies a many-sided and very varied experience. His life-like portrait of Fritsch hangs in the department. He is an expert in photography, possessing a valuable set of cameras and lenses and carrying out his own developing and printing even of several-colour processes. Equally at home in the aural and oral arts, he is a good linguist and first-class mimic, as well as a performer on the violin and viola and all kinds of brass and wood-wind instruments, of which he has a large and cherished collection.

Haines is one of the fortunate few who have so many irons in the fire that there can never be time for all. Well occupied and well deserved will be his retirement with his wife and daughter after forty years of service to the College.

Prof. C. P. Whittingham

Dr. C. P. Whittingham belongs to the type of botanist—frequently to be met in Cambridge when F. F. Blackman was the source of inspiration for plant physiology, but now quite rare—who concentrates on physics, chemistry, and mathematics at school and adds botany when he reaches the university. He entered St. John's College, Cambridge, in 1940 and, after graduating in 1943, conducted research under Prof. G. E. Blackman on field trials and on herbicides. He returned to Cambridge in 1946 to work with Prof. G. E. Briggs on photosynthesis and was awarded the degree of Ph.D. in 1949. Photosynthesis has remained his principal interest and he has established himself as a recognized authority on this subject. He collaborated with Dr. R. Hill in the production of a small monograph on the subject in 1955. Dr. Whittingham has widened his experience by close contact with other workers in this field. During the year 1949–50 he was a research fellow with Prof. Robert Emerson at the University of Illinois and spent part of the time with Prof. L. R. Blinks at Stanford University. During 1953–54 he was visiting lecturer with Prof. A. H. Brown at the University of Minnesota. Since 1950 he has held a post in the Botany School at Cambridge, first as a senior assistant in research and since October 1957 as an assistant director of research. As such he has gained experience as a teacher and as a supervisor of research students. The Department of Botany at Queen Mary College, London, is very fortunate in obtaining as its new head a man in the full tide of his research activity.

Zoology at Queen Elizabeth College, London : Prof. G. Chapman

THE announcement has recently been made of the appointment of Dr. Garth Chapman to a newly created chair of zoology in the University of London, tenable at Queen Elizabeth College. Dr. Chapman, after graduating from Trinity Hall, Cambridge, in the early years of the Second World War, was for a time engaged in radar research at the Telecommunications Research Establishment, Malvern. He joined the staff of Queen Mary College, London, shortly after the return of the College to London from its war-time quarters in Cambridge. Among Dr. Chapman's many contributions as a teacher, the initiation and development of the courses in experimental zoology will be especially remembered and appreciated. Dr. Chapman's published papers include studies on the biology of marine animals living inter-tidally and of the environmental properties of sands and other forms of particular deposits. His researches have, however, mainly centred upon the nature and functions of the hydrostatic skeleton of invertebrates and of the mesoglœa of cœlenterates. Dr. Chapman's many friends and colleagues in London and elsewhere will wish him well in his new appointment and in the opportunities afforded for developing his research and in the building up of an honours school of zoology in Queen Elizabeth College.

Sir George Earle Trophy for Industrial Safety

THE Sir George Earle Trophy for a notable achievement in the cause of industrial accident prevention has been awarded this year to Imperial Chemical Industries, Ltd., "in recognition of the far-sighted policy of its Board and its attitude towards the problems of industrial accident prevention and of the altruistic and generous way in which the extensive safety knowledge accumulated within its own organization has been made available continuously to industry throughout the world". This is the third time the Trophy has been awarded. In 1956 the recipients were H.M. Inspectors of Factories, and last year it was awarded to the Birmingham and District Industrial Safety Group. The president of the Royal Society for the Prevention of Accidents, Sir Howard Roberts, will present the Trophy, together with a commemorative plaque, at the National Industrial Safety Conference, to be held at Scarborough during May 9–11. The Trophy, a handsome silver Georgian inkstand, was presented to the Royal Society for the Prevention of Accidents in 1956 by Sir George Earle, chairman of the Associated Portland Cement Manufacturers, Ltd., for annual award for outstanding achievement in the prevention of industrial accidents by an industrial or other organization.

Emigration of Scientists and Technologists

REPLYING for the Lord President of the Council, Mr. H. Nicholls, Parliamentary Secretary to the Ministry of Works, said in the House of Commons on April 22 that further information about the emigration of qualified scientists and engineers had been obtained from a number of leading firms in response to a request from the Committee on Scientific Man-power. The investigation was continuing and it was hoped to obtain information from university professors of engineering and from the professional institutions. Most of the firms approached thought that their emigration losses were not excessive in relation to the size of their technical staff and their annual intake of scientists and engineers. It was also planned to carry out a second inquiry into the number of qualified scientists and engineers employed in Great Britain, similar in scope to the first investigation made in 1955–56. In reply to a further question, Mr. Nicholls said that the Council for Scientific and Industrial Research had recently set up an Economics Committee under the chairmanship of Prof. E. A. G. Robinson, to advise it on the economic aspects of its scientific research policy and on the probable economic value of particular researches.

Immigration of Technical Personnel to the United States

A BULLETIN prepared by the Division of Scientific Personnel and Education of the National Science Foundation gives the immigration of professional, technical and kindred workers to the United States as 59,704 during the years 1953–56, or 6·4 per cent of all immigrants, the highest annual total being 18,995 in 1956. Of this total, 9,245 were engineers, 3,231 natural scientists, 766 college presidents and deans, professors and instructors (of whom 277 were professors or instructors, including those in engineering or natural or social science), 5,023 medical men, and 6,573 technicians. Canada supplied 15,933 or 26·7 per cent of the total, and Europe 25,696 or 43·0 per cent, of whom 6,890 came from Germany and 6,406 or 10·7 per cent from the United Kingdom.

Covenanted Subscriptions to Learned Societies

NOTING that the Chancellor is now allowing contributions to professional associations to be regarded as expenses from the point of view of tax relief, Mrs. Eirene White, in the debate in the House of Commons on the budget proposals on April 16, raised the question of the position of the learned societies, and asked the Chancellor to investigate the line now being taken by the Inland Revenue on the relief of tax by means of covenanted subscriptions to learned societies. The Society of Antiquaries and a large number of small archæological societies have been placed in complete uncertainty as to their situation, and the Department of Inland Revenue has not disclosed the principles upon which it decides such matters. Neither the Financial Secretary to the Treasury nor the Chancellor referred to this point in speaking later in the debate.

Vacant Places in British Universities

IN a written answer in the House of Commons on April 21, the Financial Secretary to the Treasury, Mr. J. E. S. Simon, said he had no information about vacant places in the current university session. The report of an inquiry commissioned by the Committee of Vice-Chancellors and Principals gave 503 vacant places in science and 396 in technology in October 1955 (excluding Oxford, Cambridge and Aberdeen). Of these 70 and 51, respectively, were in the Scottish universities ; 164 and 51 in the University of Wales ; 11 and 46 in the Queen's University, Belfast ; 63 and 59 in London ; 128 and 154 at Durham, Hull, Leeds, Liverpool, Manchester and Sheffield ; 20 and 35 at Birmingham, Leicester, Nottingham and the University College of North Staffordshire ; and 47 in science at Bristol, Exeter, Reading and Southampton. Vacancies in medicine and dentistry and in agriculture and forestry totalled 131 each and in arts 1,358.

Levels of Health

Public health administrators have long been interested in devising health indices to measure the state of health of a population. At a meeting convened by the United Nations in 1953, on the international definition and standardization of measurement of levels of living, health was considered to be the most important item in a list of twelve constituent factors in standards of living. In the report of a study group acting on behalf of the World Health Organization (Technical Report Series, No. 137: Measurement of Levels of Health. Pp. 29. Geneva: World Health Organization; London: H.M. Stationery Office, 1957. 1*s.* 9*d.*) the concept of health and the knowledge available on the subject of the measurement of levels of health is reviewed. So far, the decrease in death-rates and the extension of life expectancy have been taken as indicators of improvements in the standard of health. The study group find that this procedure is not adequate. It has examined statistical data on health and suggests possible new health indicators in the fields of nutrition, environmental sanitation and mental health. It considers that counting the number of doctors and hospital beds in terms of population-ratio, without going into their effective use by the population, affords no criterion of health. The group finds that present knowledge and experience on this subject are inadequate and recommends that special field studies and research work should be carried out by medical and health institutions in order to devise more satisfactory indices for measuring levels of health, particularly the positive aspects of health.

The Selection and Training of Managers

A booklet by Col. L. Urwick answers some of the questions troubling businesses concerned with selecting and training future managers ("Sixteen Questions about the Selection and Training of Managers". By Lyndall F. Urwick. Pp. 36. London: Urwick, Orr and Partners, Ltd., 1958. 2*s.* 6*d.*). Whom should a business look for as potential managers, when and how? Having selected them, how should it train them and what facilities exist to help? Are some businesses too small to use these facilities? What will be their worst problem in training managers? Col. Urwick lists his answers in note form so that the possibilities available to a business under each question can be seen quickly. Ten years ago Col. Urwick was chairman of the government committee which established the "Urwick Syllabus" of management courses now being given in some eighty British technical colleges. The national scheme is at present under some criticism, notably from older business men and from university-educated management trainees, as being too long and too slow for their needs. Col. Urwick restates the limited aims of the national scheme and points out that different training possibilities are open to these two special categories of people.

Organization of Respiration

In an investigation of the respiration in chlorophyllous cells, W. O. James and V. S. R. Das (*New Phytol.*, **56**, 325; 1957) point out that the catalysts of respiration must be spatially separated and organized within plant cells and that they are likely to be distributed among different organelles. In particular, they have inquired if chloroplasts respire, and if they obtain products of respiration from other cell components. The materials selected for study were the young leaves of the broad bean and spinach beet, the chloroplasts being isolated and purified from accompanying mitochondria. Although highly active in the Hill reaction, these chloroplasts showed no oxygen consumption and were unable to reduce diphosphopyridine nucleotide in the dark. They could not oxidize cytochrome *c*, or any of the Krebs cycle acids, or pyruvate in the presence of malate. Broken chloroplasts showed no greater oxygen consumption than unbroken. Mitochondria from the same leaves rapidly oxidized cytochrome *c* acids of the Krebs cycle, and pyruvate after addition of malate. Light and electron microscopic observations revealed no special spatial aggregations of chloroplasts and mitochondria; but the paucity of cytoplasm in the cells causes distances between chloroplasts and mitochondria to be always very short. The authors have suggested that carbon mobilization, glycolysis and oxidation go on in the chloroplasts, 'soluble' cytoplasm and mitochondria, respectively.

Hosts of Schistosoma

With the appearance of "Intermediate Hosts of Schistosoma" by Dr. G. Mandahl-Barth (World Health Organization Monograph No. 37. Pp. 89+40 plates. London: H.M. Stationery Office, 1958. 12 Swiss francs; 20*s.*; 4 dollars), a notable advance in the field of medical malacology has been made. Here, for the first time, is a volume in which the African Planorbidae of medical importance are considered together, without regard to political frontiers, by a competent malacologist who has devoted many years to their study. Dr. Mandahl-Barth would be the last to suggest that his work is the final solution to all of the taxonomic problems in this most difficult group. It does, however, provide a reasonable classification which, if adopted by all field-workers, will serve as a sound basis for future discussion. The author deserves the gratitude of all who work on problems of medical biology in Africa.

Measurement of Air Pollution

There are several lines of approach to the study of atmospheric pollution. It can be examined around a particular source on suitably chosen occasions, with recording instruments or at least with a large number of observers. It can be studied under extremely adverse weather conditions, with a 'crash' programme employing many observers, and the taking of samples for later examination. Or it can be treated as an item of climatology, with emphasis on long-period averages and statistical deviations from them. In Great Britain the climatological treatment remains the most popular, although the other two approaches have received increasing attention recently, especially since the London fog of December 1952. There are now about 1,500 sites where atmospheric pollution is continuously measured. An attractive booklet (Measurement of Air Pollution: Recommended Methods for Deposited Matter, Smoke and Sulphur Dioxide. Pp. iii+28. London: H.M. Stationery Office, 1957. 2*s.* net) produced by the Fuel Research Organization of the Department of Scientific and Industrial Research describes the apparatus used, all of which are extraordinarily simple. The deposit gauge and the lead peroxide apparatus for sulphur dioxide require no power or water supply, though they need the services of analysts. The smoke filter and volumetric sulphur dioxide apparatus demand simple laboratory facilities, and a few minutes

attention each day. Surveys of air pollution in regions of a few square miles can be made by the lead peroxide method. The booklet also describes another kind of survey, which has perhaps been neglected because it depends on the ability to foretell 24 hr. or more of dry, calm weather. This involves the exposure of Petri dishes on pre-selected sites, and the subsequent weighing to the nearest 0·1 mgm. of the solid matter deposited in them.

Resistance Thermometry near the Absolute Zero

In recent years certain commercial carbon resistances have become increasingly important as sensitive and compact resistance thermometers for the temperature range within a few degrees of the absolute zero. They suffer, however, from the disadvantage that warming to room temperature causes their subsequent low-temperature properties to be markedly different, so that recalibration is necessary. It is now claimed by J. E. Kunzler, T. H. Geballe and G. W. Hull, of the Bell Telephone Laboratories, that germanium suitably doped with arsenic forms a sensitive and stable resistance thermometer, maintaining its calibration within a few ten-thousandths of a degree over many cycles of warming and cooling. No examples are available commercially as yet, but if it should prove possible to market reliable germanium thermometers at a reasonable price, they will be welcomed by all who perform precise thermal measurements at very low temperatures.

The Great Northern Route

V. F. Burkhanov (*Priroda* (1), 9; 1957) gives a brief history of the progress in the establishment of the "Great Northern Route" in the U.S.S.R. from the penetration of the Russian sailings on the White Sea in the ninth century, through the numerous explorations and scientific expeditions of the seventeenth and later centuries to the modern regular navigational service with its supporting new ports, river stations and an aerial network.

Electronics Convention

The thirteenth annual Electronics Exhibition and Convention, organized by the Northern Division of the Institution of Electronics, will be held during the periods July 10–12 and 14–16 at the Manchester College of Science and Technology. The Exhibition will consist of a manufacturers' section and a scientific and industrial research section, including exhibits of interest to all branches of science and industry. The Convention will include a series of lectures and film-shows on electronic topics. Admission will be free of charge. Further information can be obtained from the honorary exhibition organizer, Mr. W. Birtwistle, 78 Shaw Road, Rochdale, Lancs.

World Power Conference

The theme of the Canadian Sectional Meeting of the World Power Conference, to be held in Montreal during September 7–11, 1958, will be "Economic Trends in the Production, Transportation and Utilization of Fuel and Energy". Arrangements have been made by the Papers Committee (chairman, Sir Josiah Eccles, deputy chairman of the Electricity Council) for the preparation of sixteen papers for presentation by the British National Committee. The programme, with membership and other application forms, can be obtained from the Secretary, British National Committee, World Power Conference, 201 Grand Buildings, Trafalgar Square, London, W.C.2.

At the meeting of the International Executive Council of the World Power Conference held in Belgrade in June 1957, Bulgaria and Colombia were elected members, thus increasing the membership to fifty-two countries and territories. Major General H. A. Young, Deputy Minister of Public Works and chairman, Canadian National Committee of the World Power Conference, was elected a vice-chairman of the International Executive Council in succession to Dr. A. J. Alves de Souza, of Brazil, whose term of office had expired. The invitation of the Spanish National Committee for a Sectional Meeting of the World Power Conference to be held in Madrid in 1960 has been accepted. The sixth plenary meeting of the World Power Conference will be held in Australia in 1962, and a Sectional Meeting will take place in Switzerland in 1964.

Index of Films on Chemistry

The Royal Institute of Chemistry is preparing an index of films on chemistry, and would welcome details of any professional or amateur film that is available on loan or for hire but is not listed in the general film catalogues. Material for this index is being collected by Dr. J. H. Pryor, 3 Forsyte Crescent, Upper Norwood, London, S.E.19, to whom relevant information should be sent. The particulars required are: The title, the length, the sponsor and distributor, whether black and white or colour, whether 16 mm. or 35 mm., whether available on free loan or for hire, a brief account of the contents of the film, and the audience for which it would be suitable.

The Plastics Industry Education Fund

The Plastics Industry Education Fund was established in 1952 and the Trustees have now published their second Progress Report covering the years 1955–57 (Pp. 11. London: The Plastics Institute, 1958). The income of the Fund during this period was approximately £15,000. More than half this amount has been spent in providing training grants for students from the plastics industry to study full time at universities and technical colleges; bursaries and scholarships for boys and girls on leaving school to study full time for qualifications of the Plastics Institute or for the Diploma in Technology; a research studentship; a travel scholarship, and grants for the purchase of capital equipment at various technical colleges.

The rest of the income has been used for the publication of six monographs on plastics technology for students, on buying library books for technical colleges, on printing careers literature and on a display case on plastics at the Science Museum. Almost all the students helped by the Fund are now working in the plastics industry, and the Trustees contemplate increased expenditure on scholarships now that approval has been given by the National Council for Technical Awards for sandwich courses in plastics technology at the Birmingham College of Technology, the Borough Polytechnic and the Brunel College of Technology, Acton. Much interest is shown by students in the production of plastics materials, but a flow of technicians to the processing sides of the plastics industry is highly desirable and it is suggested that moulding, fabricating and plastics engineering firms should encourage promising personnel to broaden their technological background by the study facilities afforded by the Fund.

Association of Applied Biologists : Officers

The following officers have been elected by the Association of Applied Biologists for the year 1958–59 : *President*, Dr. I. Thomas ; *Vice-President*, Miss A. P. Wilson ; *President-elect*, Dr. R. V. Harris ; *Treasurer*, Dr. H. F. Barnes ; *General Secretary*, Dr. L. Broadbent ; *Programme Secretary*, Dr. W. G. Keyworth ; *Editor*, R. W. Marsh ; *Assistant Editor*, Dr. I. Thomas. The following new members of Council have also been elected : Dr. C. C. V. Batts, Prof. A. H. Bunting, Mr. J. Hobart and Dr. J. H. Western.

Society for the Bibliography of Natural History

The annual meeting of the Society for the Bibliography of Natural History was held at the Wellcome Historical Medical Library on March 24. The following elections were made : *President*, Dr. J. Ramsbottom ; *Hon. Secretary and Treasurer*, A. C. Townsend (British Museum (Natural History), London, S.W.7) ; *Committee*, G. F. Elliott, Dr. F. C. Fraser, F. J. Griffin, W. T. Stearn, C. Kirke Swann, Dr. D. W. Tucker.

Television Society Premiums

The Television Society has made the following awards for outstanding papers read before it during 1956–57 : *The Wireless World Premium* to Dr. D. Gabor (Imperial College of Science and Technology, London) for his paper on "A New Picture Tube" ; *The Mervyn Premium* to Dr. E. L. C. White (E.M.I. Research Department) for his paper on "Alternatives to the N.T.S.C. Colour System" ; *The Mullard Premium* to Mr. S. N. F. Doherty and Mr. P. L. Mothersole (Mullard Research Laboratories) for their paper on "Automatic Gain Control Circuits in Television Receivers" ; *The E.M.I. Premium* to Dr. J. A. Saxton (Department of Scientific and Industrial Research, Radio Research Station) for his paper on "Scatter Propagation and its Application to Television" ; *The Electronic Engineering Premium* to Dr. R. Pearce (E.M.I. Research Department) for his paper on "The Return of Electrostatic Focusing" ; and *The Pye Premiumt* o Mr. Ian Atkins (senior dramatic producer, B.B.C. Television) for his paper on "Studio Production Techniques".

Announcements

Dr. J. A. Pople, of the University Chemical Laboratory, Cambridge, has been awarded the Faraday Society Marlow Medal and Prize for 1958 for his researches on electron structure of molecules, statistical mechanics and the electrical properties of gases, and nuclear magnetic resonance. The presentation of the Medal will be made at the annual general meeting of the Faraday Society to be held in Dublin in September.

Mr. A. D. McKnight, formerly Secretary of the Department of the Army, Melbourne, has been appointed full-time executive commissioner to the Australian Atomic Energy Commission. Sir Leslie Martin, professor of physics in the University of Melbourne and chairman of the Defence Research and Development Policy Committee, has been appointed part-time commissioner. The other commissioners are Prof. J. P. Baxter (chairman), Dr. H. G. Raggatt and Mr. H. M. Murray.

On April 3 Mr. E. L. Mallalieu asked the President of the Board of Trade, in view of the public concern caused by his change of policy in appointing a Comptroller-General of the Patent Office (see *Nature*, March 15, p. 725), whether he would institute an inquiry into the working of that Office between 1926 and the present time, and publish the results. In a written answer Sir David Eccles replied in the negative.

The National Physical Laboratory, Teddington, will hold its annual open days on May 14 and 15, when the Laboratory will be on show to guests from industry, universities and government departments.

The Eighth National Congress of Chemistry, organized by the Italian Chemical Society and the Society of Chemical Industry, will be held in Turin during May 27–June 2. Further information can be obtained from the Secretary, Society of Chemical Industry, 14 Belgrave Square, London, S.W.1.

A symposium on the "Chemistry of Co-ordination Compounds" will be held in December 1958, under the auspices of the National Academy of Sciences, India. Those wishing to attend or contribute are requested to inform Dr. Arun K. Dey, Department of Chemistry, University of Allahabad, India, by June 30.

The Tenth International Congress of Genetics will be held at McGill University, Montreal, during August 20–27. There will be symposia on : structure of genetic material ; advances in human genetics ; cytogenetics and plant breeding ; genetics in animal breeding ; mutation and mutagenesis ; physiological genetics ; genetics in evolution. Further information can be obtained from Dr. J. W. Boyes, Department of Genetics, McGill University, Montreal.

A conference on the "Chemical and Physical Structure of Mucopolysaccharides" will be held on June 5 and 6 at Castle Hill, Ipswich, Mass. The conference is sponsored by the National Science Foundation and organized by the Retina Foundation. The proceedings will not be published. Besides the forty invited participants, only twenty additional scientists may attend because of the limitations of space and accommodation. Further information can be obtained from Dr. Endre A. Balazs or Dr. Roger Jeanloz (programme directors) at 30 Chambers Street, Boston 14, Mass.

A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory at Cambridge during September 15–26. It will be along similar lines to those held in previous years, but the material has been thoroughly revised and students will have access to EDSAC 2, a new and fast machine now installed in the Laboratory. Further information can be obtained from G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom completed application forms should be returned not later than June 16.

"Micro 58", an exhibition of photography with the microscope, will be held at the Polytechnic, Regent Street, London, W.1, during July 23–30. The Royal Microscopical Society extends an invitation to all photomicrographic workers to participate in this exhibition of photomicrographs, the first of what they hope will become an annual function. Series of micrographs, a coherent résumé of a study of a particular problem, or related research exhibits will be acceptable. Further information can be obtained from R. Setterington, Hon. Secretary, "Micro 58", Royal Microscopical Society, Tavistock House South, Tavistock Square, London, W.C.1.

SIR BERTRAM WINDLE, F.R.S. (1858-1929)

By Sister MONICA TAYLOR

BERTRAM ALAN COGHILL WINDLE, the centenary of whose birth occurs on May 8 of this year, was born in Mayfield, Staffordshire. His father was the Rev. Samuel Allen Windle, whose eldest brother, William, was vicar of St. Stephen's, Wallbrook, a church considered to be Sir Christopher Wren's masterpiece. Sydney Catherine Coghill, directly descended from Sir Philip Sydney through her grandfather, Chief Justice Bushe, was his mother. When Bertram was four, the family went to Kingstown, where he began to acquire that wonderful knowledge of natural history and antiquities which made him such a delightful out-of-door companion. Intensely shy by nature, he shunned the vicarage tea-parties, finding congenial companionship among the simple fisher-folk. His private school reports were, however, most unsatisfactory.

At Wells, where his parents were next to settle, because of his father's health, Bertram was fascinated by the architecture of the cathedral and the historical monuments. He haunted the vergers and acquired their arid patter so perfectly that he was allowed to take parties around on busy days. Reports from Repton, his public school, were persistently bad; the classics had no attraction for him. In after-life, Sir Bertram confessed that his great love and knowledge of English literature were initiated by one master who, on Sunday afternoons, after construing a few lines of Greek Testament, to satisfy regulations, read aloud with comments "Lycidas" and other masterpieces. Bertram longed to go into the Navy, but was refused permission, although there had been a long tradition of service in his mother's family, her father being Admiral Sir Josiah Coghill. After a particularly bad report, Bertram, inoculated with a love of chemistry by Statham's "Box of Chemical Magic", was sent to prepare for Trinity College, Dublin, the pathway to science being, in those days, via medicine. The tide had turned. Windle's examiners for Final Medicine pronounced him to be the best student they had examined in the previous twelve years. In 1883 he obtained the M.D. degree, and fifteen years later he was elected to the Royal Society.

After a short period of practice, Windle took a post as resident pathologist in the General Hospital of Birmingham. It was not Newman's influence, although being an omnivorous reader, with an accurate, retentive memory, he had read his works, but the outcome of a scientific and logical contrast between the findings of Littledale versus Ryder on Catholicism that caused him to abandon agnosticism for Catholicism.

A professorship in anatomy having been created in Queen's College, Windle, whose *métier* was science and not medicine, was appointed. The numbers, under his able guidance—for he was a born teacher though merciless to the slacker, and a strict but just disciplinarian—rapidly increased. From the first, Windle's perspicuity and his all-round culture realized that the proper home of medicine is in the university. So he approached the Right Hon. Joseph Chamberlain with his scheme for the creation of a University of Birmingham. Many of his more ambitious students had obtained university degrees as external students. Windle realized that these purely external examinations muzzled the curriculum, whereas a university should cater for the special needs of the particular environment in which it is situated.

The story of the development of the University of Birmingham with its then breath-taking modern trends is too long to narrate here. But the inclusion of faculties of dentistry, engineering, brewing, commerce, fine arts and music along with the traditional ones was a great innovation. Vast sums of money had to be raised—Carnegie was lavish, as were the local industrialists and city fathers. In little more than two years these two men, with their drive and enthusiasm, had secured everything necessary for the first congregation to confer degrees, medical graduates being duly entered on the General Register.

In addition to these academic pursuits, Windle gave many 'popular' lectures. Few possessed his gift for translating the terminology of research work into the vocabulary of the general public. Later, in Toronto, he was to secure packed halls of listeners to courses in anthropology, ethnology and archæology delivered each Friday in the Lent term. These 'University Extension Lectures' were always fully reported in the Toronto Press.

His researches were in the field of myology. Many years later, Windle was gratified to find his publications being used by Osborn and Gregory for their beautiful models in the New York Natural History Museum. His love of literature and his proximity to Stratford led to the production of "Shakespeare's Country"—a best seller. "The Malvern Country" and "Hardy's Wessex" belong to his Birmingham days. Eighteenth-century literature was, however, his hobby all his life.

It was Mr. George Wyndham who put before Windle, always an ardent Home Ruler, the patriotic reasons for his acceptance of the presidency of Queen's College, Cork, which meant considerable financial loss. In Cork, gigantic tasks awaited him, taxing even his wide academic and civic experience. The University question had to be tackled at once. Briefly, his untiring energy and his political acumen secured the National University of Ireland. In Queen's College, new chairs were established and money obtained, extensive buildings were erected, the beautiful Honan Chapel endowed, hostels for men and women secured. Nor were the needs of Ireland neglected; technical schools were established and the Irish Trade Mark was the result of his civic experience.

Windle wrote more than twenty books, mainly 'apologia' on the relations of science and religion. Feeling the need of a better philosophical training, he had at Oscott College read philosophy, Monsignor Parkinson acting as his tutor. Hence, when he retired, he accepted an invitation from the University of Toronto to found a School of Philosophy and Science in St. Michael's College, where he lectured on science and Christian philosophy.

These were his happiest years. Freed from administrative duties, he had leisure. His fame as a public

lecturer spread and he undertook extensive journeys in Canada and the United States to lecture. The Tennessee legislation had made 'evolution' a topic of burning interest. Windle wrote in all sixteen pamphlets on the subject, and his broadcasts were heard by millions of people, all to demonstrate that Christians have nothing to fear from this hypothesis.

His best-loved book, "The Church and Science", considering the rapid advance of science, remained useful for a comparatively long time. He died in Toronto on February 14, 1929.

AUSTRALIAN ATOMIC ENERGY COMMISSION

REPORT FOR 1956–57

THE fifth annual report of the Australian Atomic Energy Commission, covering the year ended June 30, 1957 (pp. 68. Sydney: Government Printer, 1957), is the most informative it has published. It shows that in the field of atomic energy, activity in Australia has been continually expanding, and though in the early days the mining of uranium was the predominant occupation, to-day atomic energy is also of considerable interest to commerce and industry.

For the first time, figures and details concerning the operations at Rum Jungle are given. Consolidated Zinc Pty., Ltd., through its wholly-owned subsidiary, Territory Enterprises Pty., Ltd., has continued to operate the Rum Jungle undertaking as agent for the Commission, and during the year under review the production of uranium oxide not only was greater than in the previous year but also exceeded the budget estimate and the rated capacity of the plant. Ore reserves at the end of June were 197,000 tons of uranium ore with a uranium content of 6·0 lb./ton; 138,000 tons of uranium–copper ore with a uranium content of 6·7 lb./ton. and copper content of 3·9 per cent; and 286,000 tons of copper ore with a copper content of 2·8 per cent.

A substantial reduction in the activities of prospecting and mining companies and of individual prospectors searching for uranium is reported. Formerly, eighteen companies were active in this field. but several have transferred their interest to other minerals, and now only five companies—four in the Northern Territory and one in Queensland—and a few syndicates are occupied exclusively with uranium. The Mary Kathleen deposit near Mount Isa in Queensland is being developed by Mary Kathleen Uranium, Ltd., which is under contract to supply its uranium oxide to the United Kingdom Atomic Energy Authority, and considerable progress is reported with the construction and development of the township and the plant for uranium production.

Since 1955 a team of the Commission's scientists and engineers have been working at Harwell, but now most of the scientific research staff have returned from the United Kingdom and resumed at the Commission's research laboratories at Lucas Heights the work commenced at Harwell. The high-temperature gas-cooled system and the liquid-metal fuel system were the two types of power reactor selected for investigation, and the results so far obtained vindicate the original choice of these systems. Both of them will eventually operate most economically on the uranium-233–thorium breeder cycle, though they may well be started with uranium-235 or plutonium. Part 5 of the annual report deals with the research programme, and Part 6 with the research establishment at Lucas Heights. Many of the buildings are now nearing completion and the erection of the High Flux Australian Reactor (HIFAR), though somewhat delayed by a variety of causes, is proceeding. This thermal reactor, which is similar to DIDO, contains a highly-enriched uranium, is cooled and moderated with heavy water, and has a heat output of 10 megawatts and a maximum flux of 10^{14} neutrons/cm.^{2}/sec. The fuel elements and heavy water are being obtained from the United Kingdom and the United States, respectively. The aluminium tank enclosing the central core of fuel elements, heavy water and control rods is surrounded by a 2-ft. graphite reflector, followed by a thermal shield, reactor steel tank and lead shield, and finally a biological shield of 5 ft. of concrete. [The reactor was started up on April 18 by the Prime Minister of Australia, Mr. Menzies.]

In addition to the research work carried out by the Commission's staff, twenty-one extra-mural research projects dealing with a variety of physical, metallurgical, engineering, chemical and biological problems are being undertaken by a number of Australian universities. The Commission has continued to give financial support for undergraduate training in those subjects important to nuclear technology in which serious shortages of trained staff exist, and eight new undergraduate scholarships were awarded in 1957 in geology, geophysics, chemical engineering and metallurgy, in addition to eighteen new postgraduate research studentships. The names of the holders of the scholarships and studentships, together with details of the research contracts; the principal publications of members of the Commission, its advisory committees and scientific staff; and the financial accounts of the Commission are listed in appendixes to the annual report.

The Isotopes Section, which was begun in July 1956, has been almost entirely confined to advising on industrial and scientific applications of radioactive isotopes, and some 200 inquiries were dealt with during the year under review. Plans for the development of the Section include the production of isotopes and research into certain aspects of technological irradiation. The illustrated booklet, "Radioisotopes in Industry and Research", by Dr. J. N. Gregory, was published in July 1956, and more than 4,000 copies have been distributed. In addition to sixteen lectures on various aspects of radioisotopes, six radio broadcasts, and television commentaries and demonstrations, "Isotopes for Industry" displays were held in Sydney and Melbourne early in 1957, which were attended by about 20,000 visitors and which aroused widespread interest. The Commission also presented a large and comprehensive display, including static and working models, and demonstrations, and covering all aspects of atomic energy, at the Royal Easter Show, in Sydney, during April 1957. The new, revised edition of the booklet, "Prospecting and Mining for Uranium in Australia", recently published by the Commission, is noteworthy for its entirely new set of colour plates of uranium minerals, and for its value to prospectors and others engaged in field operations. S. Weintroub

NATIONAL RESEARCH COUNCIL OF CANADA

REPORT FOR 1956–57

THE annual report of the National Research Council of Canada for the year 1956–57* has recently been received. Besides the reports of the president, Dr. E. W. R. Steacie, and the financial statement, it comprises accounts of the work of the two regional laboratories and of the several Divisions, including that of Administration and Awards, through which some 3·6 million dollars were allocated during the year in support of pure research in the universities. This expenditure included 540 grants and 310 scholarships and fellowships. The Senior Medical Research Fellowships offered during the past seven years have been replaced by Medical Research Associateships. Besides the information services maintained by the Division, it was responsible for publishing seven scientific periodicals, but with the issue of *The Canadian Journal of Technology* for March 1957 the Council discontinued publication of that journal.

The president's report briefly reviews the development of the work of the Council during the past forty years. The Council's scientific staff now numbers 541, including 122 postdoctorate fellows, its technical staff 819 and general service and administrative 859, while its twenty-six associate committees cover such diverse fields as aquatic biology, corrosion research, plant breeding, radio science and soil and snow mechanics. Some 7,600 technical inquiries from Canadian industries were handled during the year.

The Division of Applied Biology has made tests to obtain basic design and process information on liquid immersion freezing of poultry, and its freezing studies on milk are providing further information on the effect of cooling and freezing on the association of enzymes with particulate matter of living cells. The structure, properties and behaviour of hemicelluloses of common pulping woods are being determined to assist in the solution of manufacturing problems in using the new semi-chemical pulps. Studies of the algae *Microcystis aeruginosa* indicated that two out of nine strains were highly toxic and twelve other species or strains of algae that were suspect were essentially non-toxic. Studies of the effect of different bacteria on casein indicated that lactobacilli normally found in dairy products could utilize sodium caseinate, while lactobacilli from other sources could not. The Atlantic Regional Laboratory, Halifax, continued its studies on storage of potatoes, drying of rockweed, and deposition of pitch from sulphite pulp mills in the Atlantic Provinces, and has also completed a systematic survey of the chemical composition of peat from some of the larger bogs in the Atlantic Provinces.

Fundamental investigations at the Prairie Regional Laboratory, Saskatoon, include studies on the properties and reactions of starches, sugars, proteins, fats and oils; the physiology and biochemistry of living plants and micro-organisms; and the production of protein feed supplements by growing micro-organisms on waste sulphite liquor or molasses media.

In the Division of Applied Chemistry, fundamental studies on semiconducting oxide catalysts and on the surface properties of selected single crystals of silver have led to a better understanding of dehydrogenation and of oxidation of hydrocarbon molecules. Pilot-plant studies of the ethylene oxide process continued, and the application of spouted-bed technique to industrial drying problems has been investigated. Values have been obtained for heat and entropy changes during the catalysed reversible polymerization of α-methylstyrene and partial molar heats of solution at infinite dilution have been calculated for an alloy system by means of a simple Sommerfeld model. A study of the reaction of butene with anhydrous perchloric acid indicated that that acid alone does not cause polymerization. Some chemical fungicides promoted chemical degradation of cotton through hydrolysis or actinic breakdown of the compound. The Division of Pure Chemistry reports progress in determining the structure of several alkaloids, and further work on the vapour-phase photolysis of organic compounds has been concerned mainly with ketones (including those fully substituted with deuterium or fluorine), azo compounds, esters and peroxides, while the free radicals produced in the mercury photo-sensitized decompositions of acetone, acetaldehyde and 1 : 2- and 1 : 3-butadiene have been detected and identified and the nature and relative probability of the various modes of dissociation determined. Comprehensive measurements of specific heat have been completed for a series of alkali halide crystals and a solution calorimeter with an improved adiabatic control has been used to determine the heats of dilution of aqueous detergents. In studies of intermolecular forces which have led to a better understanding of the behaviour of molecules containing unsaturation electrons (π-electrons), nuclear magnetic resonance has proved valuable.

The Division of Applied Physics reports difficulty in recruiting first-class personnel, but in heat and solid state physics, X-rays and nuclear radiations and photogrammetry, its work continued to expand. In acoustics ear-defenders have now been combined with earphones to give greater signal-to-noise ratios and greatly improved low-frequency sensitivity and more uniform response. A new cæsium resonator has been constructed which will not be influenced by the casual disturbances that affect the mechanical vibrations of quartz oscillators. A high-temperature laboratory equipped to measure electrical and thermal conductivities up to 2,400° C. is being established. A comprehensive investigation of aerial triangulation has been begun, the method developed for analytical aerial triangulation yielding very valuable information. In the Division of Pure Physics the cosmic-ray group set up two new observing stations, one at Churchill, and the other on top of Sulphur Mountain, near Banff. Investigations continued on the behaviour of energetic nuclear particles when penetrating matter, and new spectra of chemically unstable

* Fortieth Annual Report of the National Research Council of Canada, 1956–57 (including the Annual Report of Canadian Patents and Development, Limited). Pp. 58. (N.R.C. No. 4370.) (Ottawa: Queen's Printer, 1957.)

molecules have been obtained by the flash photolysis technique. The hyperfine structures of the ground states of both stable isotopes of copper have been investigated by the atomic-beam magnetic-resonance method and the hyperfine structure anomaly determined.

The Division of Building Research steadily extended its work, completing a detailed study of the properties of asphalt singles, continuing basic studies of the movement of moisture in solid materials and making good progress in research into the strength of floating sheets of ice. In the Division of Mechanical Engineering the aerodynamics section is examining the possibilities of vertical take-off and landing, while studies with jet aircraft at high subsonic and transonic speeds demonstrated several methods of improving the characteristics of airframes and engines. Work continued in the hydraulics laboratory to provide design data for navigation locks and river improvements for several St. Lawrence Seaway projects. In gas dynamics the major design effort was on a gas turbine unit for railway traction, while much effort was given to the development of rotor de-icing equipment for helicopters, and to problems of dynamics and dynamic loading of structures. Very substantial economy in operation and maintenance of buoy lights has resulted through application of transistor circuits developed by the Radio and Electrical Engineering Division. A transmitter, power supply and antenna are under development which will survive a crash and automatically radiate a signal that can be detected by searching aircraft. A novel circuit has been developed in which a quartz crystal is used to stabilize two variable-frequency oscillators. In high-voltage research successive stages of electric-spark formation in air were photographed by using an image converter as a very high-speed optical shutter, and growth of spark diameter and brightness were correlated with various theories of spark formation. The hazard of sparks created by falling steel objects received much attention, but no ignition was obtained with drops as great as 80 ft. Tests on the St. Lawrence Seaway showed that radar shore installations would be advantageous in scheduling the arrival of vessels at lock entrances so that traffic may be handled more efficiently. A survey conducted for the Government of Newfoundland showed that a very-high-frequency radiotelephony system would provide adequate communications for vessels of the 'long liner' fishing fleets.

FIELD STUDIES COUNCIL

IN 1957 there was again an increase in the number of students attending the various field centres of the Field Studies Council and at most of them the pressure of attendances was kept up steadily throughout the season. This is brought out in the annual report (pp. 68+8 plates. London: Field Studies Council, 1958) for 1956–57, which shows that the number of students attending in 1951 had almost doubled in 1957. The new centre at Preston Montford opened in March 1957, and by the close of the season it had just managed to top the thousand mark in terms of student-weeks. Once again, the increase in numbers has been general, but in accordance with the Council's policy there has been some development of attendances from secondary modern schools, particularly at Preston Montford, where special 'country-side' courses have been provided.

The pressure at peak times of the year has continued, this being particularly pronounced in the spring, when most of the centres could fill their vacancies two and three times over. Although the opening of the new centre has gone a little way to redress the position, it, in turn, became rapidly over-subscribed at the peak of the spring period.

At the older centres the 'valleys' have been largely filled up, but it would still help if schools could arrange wherever possible to send their first-year sixth-formers at times of year which did not conflict with the peak period of bookings in April.

The Council finds itself still having to face the problem of rising costs, and this, coupled with the prospect of the Ministry of Education's grant being gradually withdrawn after 1958–59, has caused the Committee to raise again the basic charge.

The opening of any further centres is almost entirely dependent on the question of whether adequate initial capital and future support can be forthcoming from outside sources. It seems possible that at some future date an additional centre in the south-west of England might be feasible and, if this should materialize, it would mean that the Council as a whole would have a very satisfactory geographical spread over the counties of England and Wales.

SCIENTIFIC EDUCATION IN THE UNITED STATES

IN his budget message to Congress on January 13, President Eisenhower emphasized the need to expand the United States efforts in scientific research and said that this is a task for private industry, research foundations and educational institutions as well as for the Government. Supplementary appropriations for 1958 would be requested for the National Advisory Committee for Aeronautics and the National Science Foundation as well as for the Department of Defence. For 1959 new programmes to promote education in science are being recommended and basic research activities are being generally expanded. Total Government expenditure on equipment of the United States forces and those of its allies, on nuclear energy and on scientific research and education will be 21,000 million dollars in 1958 and 21,600 million dollars in 1959 compared with 20,500 million dollars in 1957. This budget, President Eisenhower added, reflects co-ordinated plans for strengthening defence, greater pooling of scientific resources and freer exchange of technological information, as well as closer economic co-operation. Expenditure by the U.S. Atomic Energy Commission will increase to 2,550 million dollars in 1959, compared with 2,300 million dollars in 1958 and 1,990 million dollars in 1957. For technical assistance, 164 million dollars are requested for 1959 and appropriations of 140 million dollars are proposed for the National Science

Foundation—more than three times the current authorization—and of this, 58 million dollars is provided for research grants, facilities and equipment and related purposes; a further 82 million dollars, or five times the present allocation, is for the expansion and improvement of scientific education.

Further details of this educational programme were given in a presidential message on education delivered to Congress on January 27. First, dealing with the National Science Foundation, the Administration recommends an increase in funds to support institutes sponsored by the Foundation for the supplementary training of science and mathematics teachers, and a somewhat larger increase to support teacher fellowships. Secondly, increased funds are sought to enable the Foundation to stimulate the improvement of the content of science courses at all levels of the educational system; thirdly, expansion is proposed of the Foundation's programmes to encourage able students to consider science as a career; while fourthly, increase in the Foundation's graduate fellowship programme is recommended, as well as the provision of funds to enable the Foundation to initiate new programmes of fellowships for secondary school science teachers during the summer months, for graduate teachers who serve during the school year as teaching assistants and for individuals seeking to extend their education and become teachers of science and mathematics in high schools.

To strengthen scientific and general education in State and local school systems, the Administration is recommending legislation to authorize additional Federal programmes for four years in the Department of Health, Education and Welfare. To reduce the waste of talent, authorization is recommended of matching grants to the States to encourage improved testing programmes to identify the potential abilities of students at an early stage in their education and also to strengthen local counselling and guidance services, so that more able students will be encouraged to stay in high school and prepare for higher education. A programme of some 10,000 new Federal scholarships annually, reaching 40,000 in the fourth year, to be closely co-ordinated with the testing and counselling programmes, is also recommended. To strengthen the teaching of science and mathematics, Federal grants to the States on a matching basis are recommended, to be used either to assist the employment of additional qualified science and mathematics teachers, or for the purchase of laboratory equipment or to supplement salaries.

To increase the supply of teachers the Administration is also recommending the provision of graduate fellowships to encourage more students to prepare for college teaching careers, and of Federal grants on a matching basis to institutions of higher education, to assist in expanding their graduate-school capacity. Provision is also recommended of a four-year programme in support of special centres in colleges and universities for instruction in important foreign languages which are not now commonly taught in the United States, and of institutes for those who are already teaching foreign languages in schools and universities where the quality and effectiveness of such teaching could be improved. Finally, the Administration recommends that the Office of Education be authorized to make grants to State agencies for improving the collection of statistical data about the status and progress of education.

Throughout both messages the President emphasizes the bearing of all these educational recommendations on national security.

SPATIAL AND TEMPORAL VARIATION OF MICROFIBRILLAR ORGANIZATION IN PLANT CELL WALLS

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THE molecular structure of the solid envelope which surrounds every plant cell has been the subject of intensive investigation for many years. This cell wall is composed of a complex mixture of polysaccharides, of which the celluloses have proved to be of greatest importance, both as the major structural component and economically. Theories concerning the micellar structure of this 'skeletal' cellulose aroused much controversy until the advent of the electron microscope, when by means of this instrument it became possible to make direct observations. The first electron micrographs of untreated and undistorted cellulose were obtained in this Department in 1948[1], using the cell wall of the green alga *Valonia*. This cellulose is in the form of long flattened threads, called microfibrils, which range in diameter from 250 to 300 A., and are apparently endless. Afterwards, from examinations of a variety of plant materials, including higher plants, it has become evident that microfibrils are a characteristic feature of plant cell walls. These microfibrils vary between 100 and 300 A. in diameter, depending upon source and pretreatment. As they occur within the cell wall, these microfibrils may be oriented and virtually straight, as, for example, in Fig. 1, or have a random arrangement with the microfibrils intertwined, as in Fig. 2. Despite the striking difference in appearance of these two types, until recently there has been a tendency to assume that all microfibrils are cellulosic in nature. The purpose of this article is to direct attention to the implications of recent work carried out in this and other laboratories, indicating that the situation is more complex.

Let us first consider the condition existing in the types showing oriented microfibrils. The best examples may be found in the mature walls of certain of the green algae, notably *Valonia*, *Cladophora* and *Chaetomorpha*. X-ray diffraction analysis indicates that the microfibrils are highly crystalline and are composed of cellulose I[2,3]. On hydrolysis the cellulosic fraction yields glucose with but a trace of other sugars. These microfibrils may be regarded, therefore, as being composed of pure cellulose.

A study of some examples of cell walls containing only random microfibrils has been made in this Department[3]. A number of species of the red algae have been examined, combining chemical analysis

Fig. 1. Electron micrograph of a single lamella stripped from the cell wall of a mature vesicle of *Valonia*. Palladium/gold shadowed (× 30,000)

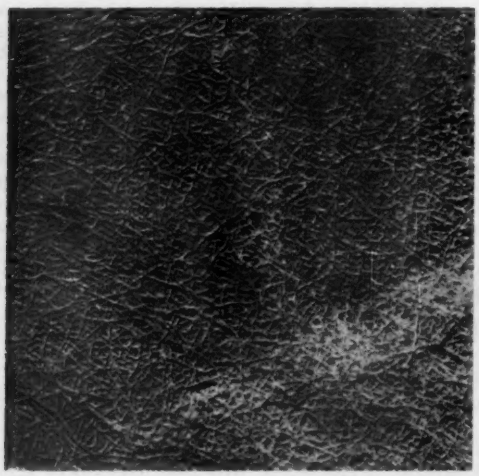

Fig. 2. Electron micrograph of the cell wall of *Rhodymenia palmata* treated to remove all non-microfibrillar material. Palladium/gold shadowed. (× 22,500)

with electron microscopy and X-ray diffraction analysis. As an example from this group, an electron micrograph of the 'α-cellulose' of *Rhodymenia palmata* is presented in Fig. 2. The microfibrils show no sign of orientation. They are, however, crystalline, but do not give an X-ray diffraction pattern in any way resembling cellulose I. Hydrolysis followed by paper chromatography of the resultant sugars indicates that these microfibrils are built up of approximately equal quantities of glucose and xylose residues. As an example of an extreme case in which the microfibrils are completely non-cellulosic, *Porphyra* may be considered. The cell wall of this alga contains random microfibrils which are built up of mannose, galactose and xylose residues, and which contain no detectable glucose residues. These unusual microfibrils are by no means confined to the algae. Recent work by Meier[4] has demonstrated the presence of mannan microfibrils in the cell walls of palm seeds.

Contrary to the often expressed view that all celluloses are identical irrespective of their origin[5], the conclusion to be drawn from the examples quoted above is that the microfibrillar fraction is not necessarily built solely of 1 : 4β-linked glucose residues. It is, perhaps, not entirely surprising that microfibrils from such widely varying sources show differences of this kind, and the recent demonstration by Nicolai[6] of the same type of variation within one species is therefore of fundamental importance. The development of growing walls of sporelings of *Chaetomorpha* was studied by means of electron microscopy and X-ray diffraction analysis. The first-formed wall around the naked protoplast was found to be composed of completely random microfibrils. Subsequent development of wall layers internal to this showed the oriented microfibrils characteristic of the mature wall. X-ray diagrams of sporelings in which only the random microfibrils were present did not give the characteristics of the cellulose I diagram. Thus it has been conclusively demonstrated that, within a single cell wall, microfibrils which in the electron microscope can be distinguished only on the basis of their arrangement, that is, random or oriented, are physically different.

In higher plants both random and oriented types of microfibrillar organization occur. The former is associated with the first-formed layer of the cell wall, and the latter with subsequent layers. This has been demonstrated in a variety of materials, including oat coleoptiles, wood tracheids and root hairs[7,8] (Fig. 3). To our knowledge there has been no chemical analysis of isolated samples of random and oriented micro-

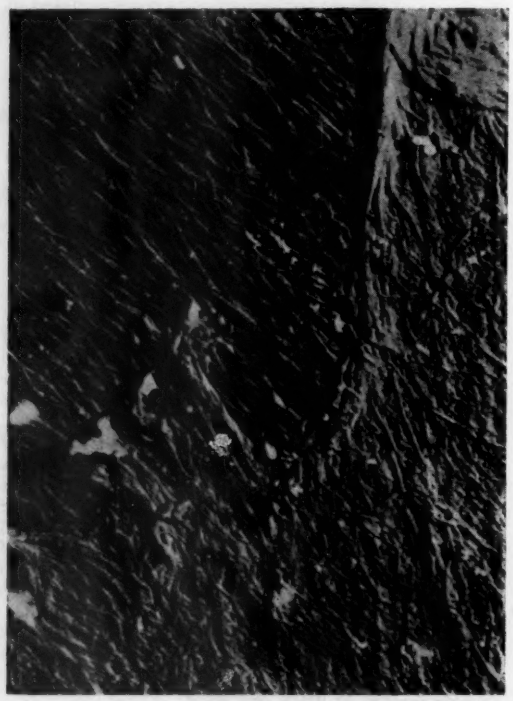

Fig. 3. Electron micrograph of the cell wall of a root-hair of white mustard treated to remove all non-cellulosic material, showing the outer random and inner oriented layers. Palladium/gold shadowed. (× 30 000)

fibrils from higher-plant material, owing to the extreme difficulty of complete separation. Analyses of α-cellulose isolations from higher-plant materials, containing both random and oriented microfibrils, always reveal the presence of significant amounts of sugar residues other than those of glucose. Thus, although direct evidence is lacking, it would appear reasonable to assume differences, chemical or physical, between random and oriented microfibrils.

Hitherto, cells walls of higher plants have been sub-divided into primary cell walls and secondary cell walls. The primary wall is defined as the wall surrounding a growing cell, whereas subsequent layers, laid down largely after the cell has ceased to increase in size, are referred to as secondary wall layers. These terms do not imply any inherent differences in the constitution of primary and secondary walls, the definitions being based upon developmental stages of the cell. With the discovery of the two types of microfibrillar organization described above, confusion has been created by identifying the random layer of microfibrils with the primary wall, and the oriented layers of microfibrils with the secondary wall. For example, a rapidly growing cell such as a root-hair is surrounded by a primary wall, but as we have seen above, this wall includes a layer of oriented microfibrils. The description, by electron microscopists, of this layer of oriented microfibrils as secondary[7] is not in accordance with the definition of the term secondary wall. We would, therefore, suggest that in order to avoid further confusion the terms primary and secondary cell wall be retained in their original sense, and that new terms be introduced for describing the two conditions of microfibrillar organization revealed by the electron microscope.

We propose that a random layer of microfibrils be termed an α-layer, and that an oriented layer of microfibrils be termed a β-layer. Thus, the primary wall of a higher plant cell, such as a root hair, contains both α- and β-layers.

Apart from the differences in microfibrillar arrangement, the α- and β-layers may be further distinguished by the relative amounts of amorphous material present. Whereas the individual microfibrils of the β-layer are clearly visible in the electron microscope, those of the α-layer are masked by the presence of large amounts of pectins and hemicelluloses if examined without pre-treatment. It will be realized, therefore, that microfibrils of the α-layer are embedded in a mucilaginous matrix, and when such a layer is passively extended, as, for example, in certain phases of growth, some orientation of the microfibrils may be induced, as in growing cotton hairs[7]. This layer may be described as an α-layer showing a net preferred orientation; there is no similarity to the well-oriented β-layers.

Since the terms primary and secondary cell wall apply only to higher plants, the introduction of the new terms has an additional advantage in that they may be applied throughout the plant kingdom. For example, the cell walls of the red algae are built up solely of successive α-layers. *Chaetomorpha*, on the other hand, after forming a single α-layer, increases cell wall thickness by the deposition of β-layers.

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[2] Cronshaw, J., and Preston, R. D., *Nature*, **181**, 248 (1958).
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[4] Meier, H., Proc. Stockholm Conf. on Electron Microscopy, 298 (1956).
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[6] Nicolai, E., *Nature*, **180**, 491 (1957).
[7] Houwink, A. L., and Roelofsen, P. A., *Acta. Bot. Neerlandica*, **3** (3), 385 (1954).
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BIOGEOGRAPHY OF THE NEW HEBRIDES

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A SYSTEMATIC review of the New Hebridean land and freshwater molluscs led to a general survey of the geography of Pacific Ocean snails and a detailed consideration of New Hebridean biogeography[1]. The systematic data and distributional surveys are contained in a longer report, but the probability of an additional one- or two-year delay in publication and the recent work by Miss E. L. Cheesman[2] make preliminary recording of the general conclusions worth while.

The distribution patterns of Pacific land snails show several remarkable features in comparison with those of other animal groups. Excluding the West Indian and African 'tropical tramps', which the Caucasians introduced into the Pacific, and perhaps a dozen species accidentally transported by natives, the land snails show almost 100 per cent specific endemism for each archipelago. Even on the level of sectional, subgeneric and generic classification, there is a very high degree of endemism. Most groups of organisms show either 'Malayan' or 'Australasian' elements; but the land snails have three types of distribution, which I have termed Palæo-Oriental ('Malayan'), Southern Relict ('Australasian'), and Pacific Ocean ('Polynesian').

The Palæo-Oriental fauna (key taxa—Cyclophoridae, Camaenidae, Rathouisiidae) extends from the Malay Peninsula through New Guinea to the Solomon Islands and down the Pacific coast of Queensland into northern New South Wales. There it meets and mingles with the Southern Relict fauna in what Iredale[3] termed the 'Oxleyan' subregion. The central portion of Australia is a 'molluscan desert' inhabited primarily by snails of the family Camaenidae (this includes the Papuinidae, Chloritidae, Hadridae, Rhagadidae, Xanthomelonidae, etc., of Iredale). The Southern Relict fauna (key taxa—Paryphantidae, certain Endodontidae, Bulimulidae) dominates the southern portion of Australia, New Zealand, Tasmania and New Caledonia.

The high islands of Polynesia and Micronesia have a few families (Pupinidae, Diplommatinidae, Trochomorphinae) which represent partial penetration of the Palæo-Oriental fauna, but more important, endemic (Partulidae, Poteriidae), nearly endemic (Tornatellinidae, Omphalotropidinae), and spectacularly developed (Endodontidae, Microcystinae) family units. The famous Hawaiian Achatinellidae and Amastridae are deliberately excluded, since they

probably represent local derivations from widely distributed families.

On the islands of Melanesia there is an intermingling of the three faunas. The Solomons are dominated by the Palæo-Oriental, Fiji by the Pacific Ocean, New Caledonia and the Loyalty Islands by the Southern Relict, and the New Hebrides have a nearly balanced mixture of the three types.

This situation is quite different from that found in the vertebrates, where New Guinea has an Australian fauna; there are no taxa of major size restricted to the Pacific Islands, and there is a very low degree of endemism on the 'oceanic' islands. Many groups of insects found in New Guinea are of 'Malayan' affinities, and botanists have included New Guinea in the 'Oriental' region for many years. There seems to be a fundamental difference between the present distribution patterns of the vertebrates on one hand, and the insects, snails and vascular plants on the other.

The differences are undoubtedly the result of a complex interaction of several factors, among them rapidity of dispersal, ability to cross filter zones, degree of climatic dependence, and, perhaps most important, time of adaptive radiations and major dispersions. The distribution of vertebrates is clearly the result of Tertiary phenomena. In land snails, palæontology shows that the present distribution of Patagonian non-marine molluscs was essentially established by the Cretaceous. The land snails may thus represent a relict pattern caused by early isolation, and the vertebrates, plus to a lesser extent the insects and vascular plants, are later arrivals which have successfully crossed filter zones which excluded the more recent types of land snails.

The floristic affinities of New Caledonia and the southern New Hebrides are well established by botanical studies, and Miss Cheesman[2] has indicated that some insects of the two areas are quite similar. It is equally well known that the northern New Hebrides have a much larger representation of 'Malayan' plants and 'Papuasian' animals. It was originally expected that the land snails would show similar distributions.

They most emphatically did not. Of the 73 New Hebridean land-snail species, 15 are recent introductions or widely distributed over most of the Pacific (by natives ?), 57 are endemic, and only 1 (*Draparnaudia singularis* Pfeiffer) is found on one other island group (New Caledonia). No important faunal differences could be found between the northern New Hebrides (including the Santa Cruz Islands) and the southern New Hebrides. Rather than a north–south distinction, Espiritu Santo has a modified fauna, while the snails of the southern New Hebrides and the Santa Cruz Islands are very similar. Apparently the insects[4] of the Santa Cruz Islands are New Hebridean, although the reptiles and birds[5] are composed of Solomon Island, Fijian and New Hebridean taxa.

There are very great differences and only a few similarities between the land snails of the New Hebrides and those of New Caledonia. Four families (two—Pupinidae, Trochomorphinae—of the Palæo-Oriental fauna and two—Partulidae, Microcystinae—of the Pacific Ocean fauna) found in the New Hebrides do not reach the Loyalty Islands or New Caledonia. The endemic species of New Hebridean land snails are placed in 24 genera. Only 8 of these are also found on New Caledonia (compared with 14 on Fiji). 4 of the 8 are widely distributed over the Pacific, 2 are represented by different subgenera, and only 2 (*Aneitea* and *Draparnaudia*) show any close relationship.

When viewed as a unit, the New Hebridean land snails show as much affinity to the New Zealand fauna as the New Caledonian, and in some taxa there is a much closer relationship. A definite phylogenetic sequence can be recognized in the bulimuline land snails of the Pacific. The west Australian and Tasmanian *Bothriembryon* is the most primitive and nearest the South American Bulimulidae. Very close to *Bothriembryon* is the New Hebridean endemic *Diplomorpha*, which forms a transition, both in anatomy and shell, between the generalized *Bothriembryon* and the specialized *Placostylus*. Within the diverse group lumped as '*Placostylus*', the species of the New Hebrides, New Zealand and Lord Howe Island form a closely related series with many primitive features; the species of New Caledonia and the Loyalty Islands are more specialized; and those of the Solomon Islands and Fijis are quite specialized.

If, as Miss Cheesman[2] suggested, the southern New Hebrides and New Caledonia had been connected by dry land in the late Miocene and early Pliocene, one would expect much greater affinities between the land snails of the two areas. In the Greater Antilles, Miocene land snails belonged to the same subgenera living there to-day, and a similar evolutionary conservatism would be expected in the New Hebrides and New Caledonia.

Geological evidence militates against any New Caledonian–New Hebridean land mass. An ocean trench of more than 21,000 ft. separates Aneiteum and the Loyalty Islands, and the formations on the southern New Hebrides suggest that emergence, rather than submergence, has been the late Tertiary history of the New Hebrides. The present contours of the ocean floor suggest that New Caledonia and the New Hebrides may have had separate land connexions to New Guinea, rather than any joint connexion.

Any attempt to explain the origin of the New Hebridean biota must account for all elements and not just a few species. The present distributions and probable phylogenies of the Pacific land snails suggest a general pattern of origin which is not contradicted by the limited evidence afforded by modern vertebrates or currently available for vascular plants and insects. Involved in the hypothesis are several assumptions which are documented in the complete report[1].

Land snails essentially radiated in the late Palæozoic, and many of their present disjunctive southern distributions were established in the late Mesozoic. Freshwater snails are often passively dispersed; but most large land snails are nearly restricted to dry-land passage. The land snails of the Pacific islands are small in size and have habits which allow overseas dispersal at infrequent intervals. Present land-snail faunas of the southern hemisphere came from the north and were not derived via Antarctica or any South American–Australian land bridge. The primitive land snails have been preserved in these southern refuge zones with some specific radiations, but apparently with little or no progressive evolution.

The land snails of the Southern Relict fauna belong to some of the most primitive phyletic lines of the land snails. Both Australia and New Zealand received

this fauna; but the derivation was in each case from New Guinea—New Zealand's portion passing through the Solomons, New Hebrides and/or New Caledonia before reaching New Zealand. A few relict snails of the original migrations are still preserved in the New Hebrides (some endodontids and the bulimulids *Placostylus* and *Diplomorpha*). Similarly, south-west Australia has some of the same basic elements persisting. New Caledonia had a longer connexion with New Guinea, since the Southern Relict species of New Caledonia conform more to Tasmanian types than any New Hebridean, south-west Australian or New Zealand species.

New Zealand, south-west Australia and to some extent New Caledonia and south-east Australia, have been effectively isolated from further molluscan colonization: New Zealand and New Caledonia by the present water barriers, south-west Australia by the central Australian desert (a former sea) and south-east Australia and Tasmania by the Great Dividing Range. The time of this first detectable wave of immigrants was probably not later than the mid or early late Mesozoic. The means of arrival was probably essentially dry-land passage.

Australia received three additional waves of immigrants—the mesurethran relict Caryodinae (Queensland to Tasmania), the many genera of Camaenidae, and in the late Tertiary the Palæo-Oriental fauna of coastal Queensland. Again these taxa probably arrived over essentially dry land.

In contrast, New Caledonia has received a few, and the New Hebrides many additional genera. To understand this, we must first consider the Pacific Ocean fauna. Many of the families seem to be older than the Southern Relict forms (phyletically). Yet within each family there is usually no clear pattern of supra-specific divergences. We thus have a phylogenetically old fauna with little evidence of any evolutionary divergence (a juvenile characteristic). This seeming contradiction can be resolved through recently acquired geological knowledge. The Tertiary has seen a marked subsidence of the ocean floor in Micronesia and Polynesia, and many formerly existing high islands are now beneath the surface. Isolated high islands have probably existed in the Pacific Basin throughout most of geological time. The present islands are infinitely younger, but a biota capable of crossing ocean gaps at infrequent intervals could survive almost indefinitely by 'hopping' from sinking islands to newly elevated ones. The present snail fauna could thus have entered the Pacific even in the Palæozoic, and survived by occasional 'island-hopping'; and the wide water gaps of the Tertiary prevented the additional population of the islands with the advanced land snails. The 'constant' island-hopping would explain the lack of clear evolutionary divergence.

The additional Palæo-Oriental and Pacific Ocean snail taxa of the New Hebrides thus require only the presence of more isolated high islands (and smaller water gaps than now exist). The failure of many taxa to cross from the New Hebrides to New Caledonia is remarkable. These same taxa have replaced the New Caledonian ones on the continents; and introduced species are flourishing on New Caledonia. Possibly the water gap from Aneiteum to the Loyalty Islands is beyond the limit of successful chance dispersal, but there may be other factors involved.

The above hypothesis is based on the entire land snail fauna of the Pacific region. In comparison with the many families and genera of snails, there are very few vertebrates to be considered. The New Zealand frog (*Leiopelma*) and tuatara (*Sphenodon*), the Fijian frogs (*Platymantis* and *Cornufer*) and iguanid lizard (*Brachylophus*) are relicts that could be considered of Mesozoic origin. The Fijian frogs are controversial, and there are iguanids on Madagascar; but the New Zealand genera have no Old World (*Leiopelma*) or living (*Sphenodon*) relatives. In contrast to these relicts, the modern vertebrates show very little endemism and clearly indicate fortuitous dispersal over ocean barriers. Thus the Santa Cruz Islands have six Solomon Island reptiles not found in the New Hebrides, and there are nine New Hebridean reptiles on the Loyalty Islands, but only five on New Caledonia. In the vertebrates, we have a few old relicts and many forms derived by overseas dispersal.

Few insect or plant families have been studied in enough detail to allow general distribution patterns to be formulated. Groups with low dispersal facilities, such as the caddis-flies[6], conform well with the land-snail patterns. Other insects and plants have good chances for accidental dispersal, and most of the New Caledonian–New Hebridean affinities are probably the result of such accidental transport. With the narrow water gap, it is quite probable that the few New Hebridean–New Caledonian land snail relationships are also due to passive dispersal.

For island areas with few vertebrates, biogeography must lean heavily upon data from invertebrate and plant distributions. Breeding populations of vertebrates need much more room than those of plants and invertebrates. Thus extinction of island vertebrates is much more likely than of island invertebrates. The absence of extensive vertebrate faunas may indicate that an area has been 'oceanic' during the Tertiary, but careful study of the non-vertebrate biota may reveal distribution patterns more easily explained as Mesozoic relicts. The data assembled on Pacific land snails suggest quite a different zoogeography and history than the data known for the vertebrates. Whether insect and plant distributions will correspond more to the land-snail or the vertebrate patterns can only be determined by future revisionary studies.

Apparently the New Hebrides are an area where biotas mix. The degree and type of mixing have been complicated for each phyletic unit by the time, extent and available means of dispersal. Some taxa have been able to pass ocean barriers readily; others appear to be much older relicts isolated by the submergence of former land bridges. The plants and some insects show New Caledonian–New Hebridean affinities; the land snails do not. The striking climatic change from the northern to the southern New Hebrides probably accounts for the floristic differences. The similar climates and narrow water gaps probably account for the floristic and entomological similarities of New Caledonia and the southern New Hebrides. Use of these changes and similarities to assume a New Caledonian–New Hebridean land connexion and a 'Wallace's Line' in the New Hebrides is flatly contradicted by evidence from the land snails, which appear to be a group less apt to be passively dispersed than most insects or plants.

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ENZYMATIC ABNORMALITY IN ERYTHROCYTES OF A POPULATION SENSITIVE TO *VICIA FABA* OR HÆMOLYTIC ANÆMIA INDUCED BY DRUGS

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HÆMOLYTIC reactions due to *Vicia faba* or certain drugs (sulpha drugs, *p*-aminosalicylate or naphthalene) occur in Israel only in dark-complexioned non-Ashkenazy Jews of Oriental or Mediterranean origin. Our previous investigations revealed glutathione deficiency and instability[1,2] in the erythrocytes of these cases. Carson *et al.* described a defect of glucose-6-phosphate dehydrogenase in erythrocytes of American primaquine-sensitive subjects, having similar glutathione abnormalities[3–5]. Following these reports, we investigated the activity of this dehydrogenase in the erythrocytes of our sensitive population.

Thirty control subjects and twenty-six 'sensitive subjects' whose red blood-corpuscle glutathione was sensitive to acetyl phenyl hydrazine were investigated.

The reaction system was essentially identical with that of Carson *et al.*[3]. The activities of glutathione reductase, glucose-6-phosphate (G-6-P) and 6-phosphogluconate dehydrogenases were estimated by the quantities of reduced glutathione (GSH) formed by the coupled reactions (1)–(2) or (1)–(3).

$$\text{GSSG} + \text{TPNH} + \text{H}^+ \xrightarrow[\text{reductase}]{\text{GSSG}} 2\text{GSH} + \text{TPN}^+ \quad (1)$$

$$\text{G-6-P} + \text{TPN}^+ \xrightarrow[\text{dehydrogenase}]{\text{G-6-P}} \text{6-P-G} + \text{TPNH} + \text{H}^+ \quad (2)$$

$$\text{6-Phosphogluconate} + \text{TPN}^+ \xrightarrow[\text{dehydrogenase}]{\text{6-phosphogluconate}} \text{pentose phosphate} + \text{CO}_2 + \text{TPNH} + \text{H}^+ \quad (3)$$

In all experiments, fresh (not more than 2 hr. old) heparinized blood was used. It was centrifuged in the cold, the red corpuscles were washed thrice with cold saline (4° C.) and hæmolysed with 5 vol. of cold distilled water. The hæmolysates were usually divided into four parts, each being treated differently: (*a*) immediate dialysis for 18 hr. in the refrigerator with 0·067 *M* phosphate buffer *p*H 7·4; (*b*) incubation at 37° C. for 1 hr. prior to dialysis; (*c*) centrifugation for 1 hr. in a refrigerated centrifuge at 16,000*g* followed by dialysis of the supernatant hæmolysate; (*d*) incubation of the supernatant (obtained as in (*c*)) at 37° C. for 1 hr. before dialysis.

2 ml. of hæmolysate were mixed with constituents appropriate for each reaction and the volume was made up to 3 ml. with *tris* buffer. The concentrations of the various reagents in the final reaction mixtures were: *tris* (hydroxymethyl) aminoethane 0·048 *M*, *p*H 7·4; triphosphopyridine nucleotide 1×10^{-5} *M*; glucose-6-phosphate 5×10^{-4} *M*, 6-phosphogluconate 2×10^{-4} *M*; oxidized glutathione (GSSG) $3{\cdot}5 \times 10^{-4}$ *M* (0·64 mgm./3 ml. mixture). All the reagents were dissolved in the *tris* buffer. After incubation for 15 min. at room temperature, the reaction was stopped by the addition of 5 ml. of 3 per cent metaphosphoric acid. The reduced glutathione was determined by the method of Grunert and Philips as modified by Beutler[6].

When the incubation mixtures contained 6-phosphogluconate (coupled reactions 1 and 3) the amount of reduced glutathione formed in all the samples (normal and sensitive) was similar (range 0·20–0·30 mgm./3 c.c. mixture). It may be concluded, therefore, that no abnormality in the activities of 6-phosphogluconate dehydrogenase and glutathione reductase was demonstrated in blood of sensitive subjects.

Table 1. Reduced Glutathione found in Experiments with Glucose-6-phosphate as Hydrogen Donor (Coupled Reactions 1–2)

Subjects	No. of subjects	GSH mgm./3 ml. mixture formed Type of hæmolysate			
		a	*b*	*c*	*d*
Normal ♂ or ♀	30	0·21–0·32	0·20–0·30	0·20–0·34	0·19–0·43
Sensitive ♂	15	0	0	0–0·04*	0–0·02*
Sensitive ♀	2	0	0	not performed	
Sensitive ♀	4	0·06–0·12	0·04–0·10	0·30–0·35	0·23–0·30
Sensitive ♀	2	0·20–0·28	0·06–0·10	0·32–0·35	0·20–0·22
Sensitive ♀	3	0·20–0·30	0·19–0·24	0·26–0·35	0·22–0·30

Hæmolysates (*a*), (*b*) contained stroma; (*c*) and (*d*) were supernatants after high-speed centrifugation in the cold. Hæmolysates (*a*), (*c*) were kept at 4° C. throughout the preparation; (*b*) and (*d*) were incubated at 37° C. for 1 hr. before dialysis.
* Only four subjects tested.

When glucose-6-phosphate was used as the hydrogen donor (coupled reactions 1 and 2), different grades of abnormalities were observed (Table 1). In the hæmolysates from all sensitive males and two females no glucose-6-phosphate dehydrogenase activity could be detected in samples which contained stroma, even if kept all the time at 4° C. After removal of stroma only trace activities could be detected in some of them. In most samples from sensitive women, normal activity was seen when stroma-less supernatants were examined, but hæmolysates containing stroma showed markedly diminished activity. Only in some cases incubation at 37° C. was required to show this effect. Finally, in three women which were sensitive to Beutler's test no abnormality in this dehydrogenase activity could be shown.

In most cases containing unstable erythrocyte glutathione, an abnormality of glucose-6-phosphate dehydrogenase activity was demonstrated. This abnormality showed variable expression, which was probably sex linked or sex conditioned.

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LETTERS TO THE EDITORS

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Use of an Analogue to resolve Stokes's Paradox

THAT the stream-function (ψ) defining slow, steady, laminar motion of an incompressible and viscous fluid satisfies an equation identical in form with that which governs the displacement (w) of a bent elastic plate was remarked both by Lord Rayleigh[1] and by Lamb[2]; but neither seems to have had recourse to the analogue to resolve what Birkhoff[3] has termed "Stokes' paradox"—namely, Stokes's failure to find a solution for slow flow past a cylinder, after treating successfully the problem of slow flow past a sphere.

Stokes attacked both problems in a classic paper[4] concerned with the motion of pendulums. Assuming the sphere or cylinder to be held fixed and the fluid in contact with it to be brought to rest, he postulated that at all infinite distances from its centre (or its axis)

$$\left.\begin{array}{l} u = \mathbf{U}, \text{ a constant (and very small) velocity,} \\ v \text{ (the perpendicular component of velocity)} \\ \quad = 0 \end{array}\right\} \quad (1)$$

For the sphere, these postulates yielded an acceptable solution; but for the cylinder he found them impossible to satisfy, except by the null solution $\mathbf{U} = 0$ (which implies that the whole mass of fluid has the velocity of the cylinder). His explanation is cited by Lamb[5], who seems to have accepted it.

But a different explanation is forthcoming when use is made of the above-mentioned analogue. In the absence of body-forces, the equations governing steady laminar motion are:

$$l[u.\partial/\partial x + v.\partial/\partial y](u,v) + [\partial/\partial x, \partial/\partial y]p = \mu\nabla^2(u,v) \quad (2)$$

(∇^2 standing for $[\partial^2/\partial x^2 + \partial^2/\partial y^2]$), when the fluid is incompressible, so that

$$\partial u/\partial x + \partial v/\partial y = 0 \quad (3)$$

and (2), when p is eliminated, yield the relation

$$\left.\begin{array}{l} u.\partial\zeta/\partial x + v.\partial\zeta/\partial y = \nu\nabla^2\zeta \\ \text{when } \nu \equiv \mu/\rho \text{ and } \zeta \equiv (\partial v/\partial x - \partial u/\partial y), \\ \text{also (3) permits the substitutions} \\ \quad u = \partial\psi/\partial y,\ -v = \partial\psi/\partial x,\ -\zeta = \nabla^2\psi \end{array}\right\} \quad (4)$$

In very slow motion (all of u, v and ζ being infinitesimal) the terms on the left of the first of (4) are negligible, and that equation is replaced by:

$$\nabla^4\psi(= -\nabla^2\zeta) = 0 \quad (5)$$

which has the same form as the plate-flexure equation:

$$\nabla^4 w = Z(x,y) \quad (6)$$

when the surface-intensity of the transverse loading, $Z(x,y) = 0$.

Thus (by identification of ψ and w) any solution of the flexural equation (6) can be interpreted as a solution of the hydrodynamic equation (4), and vice versa. In Stokes's problem ψ is governed by (5), so in its flexural analogue $Z(x,y)$ is zero everywhere: thus the flexural analogue is a plate which sustains no transverse loading but is bent (if at all) solely by actions applied at its edges (boundaries). Its inner boundary is the circle ($r = a$), corresponding with the surface of Stokes's circular cylinder; and at this (fixed) surface the fluid is brought to rest so that $u = v = 0$ as given in (4), therefore in the analogue $\partial w/\partial x = \partial w/\partial y = 0$ at the inner boundary. Its outer edge is the boundary of Stokes's field of fluid, and here, according to (1),

$$\partial\psi/\partial y = \mathbf{U}, \quad \partial\psi/\partial x = 0, \quad \text{so } \psi = \mathbf{U}y \quad (7)$$

when the x-axis is the line of symmetry on which $\psi = 0$. Accordingly, in the flexural analogue of Stokes's problem

$$\left.\begin{array}{l} w = \partial w/\partial r = 0 \text{ at the inner (circular) boundary, which thus is 'clamped' in the } x\text{-}y \text{ plane,} \\ w = \mathbf{U}y \text{ at the outer boundary, which thus lies in a plane containing the line of symmetry and inclined to the } x\text{-}y \text{ plane at an angle } \tan^{-1}\mathbf{U}. \end{array}\right\} \quad (8)$$

The planes of the inner and the outer edge coincide only if $\mathbf{U} = 0$ (implying a null solution of the hydrodynamic problem).

But from the analogue it is apparent that Stokes's postulates (1) are inadmissible. For if (1) were satisfied exactly at all infinite distances from the cylinder, then at such distances all second and higher derivatives of ψ would be strictly zero and hence, in the analogue, all second and higher derivatives of w; and from this it would follow that in the analogue neither stress-couples nor shears act on the plate's outer boundary, consequently no action is available to oppose the 'clamping' couple which must act on its inner edge (because otherwise the plane of that edge would rotate so as to relieve the flexural stresses). Whatever the shape and size of the outer boundary, having fixed its displacement by imposing (8), we may only (w being biharmonic) impose one more condition at any point on it. We can, for example, require $\nabla^2 w$ (and hence $\zeta = -\nabla^2\psi$) to be zero; but we may not also require ζ to have a zero normal gradient—as it would be if Stokes's postulates were admissible.

Of course, when the outer edge is very large in relation to the circle ($r = a$), very small line-intensities of edge-moment and/or shear will suffice to produce the balancing couple. What is asserted here is that both cannot be strictly zero at every point, because the couple required for balance must have non-zero magnitude (for non-zero $\mathbf{U}$ and a). In effect, Stokes's postulates (1) impose more boundary conditions than the two that may be imposed on a biharmonic function; and his omission to recognize this would seem to have been due to the fact that no like failure had resulted in his similar treatment of slow flow past a sphere. There, two relations like (1) *are* satisfied at all infinite distances from the centre of the sphere; and Stokes remarked "... it happens that the second ... leads to precisely the same equations ... as the first"[6]. But whatever two conditions be imposed on a biharmonic function at a boundary, an indefinite number of other, formally different, conditions will 'happen' to be satisfied. It does not follow that it would have been legitimate to impose them, as Stokes seems to have concluded.

In a paper not yet published, Prof. D. N. de G. Allen and I have adduced arguments to show that Stokes, by imposing (1), omitted to make provision of any force to oppose the 'drag', and that for this reason no non-zero solution could be expected. Here I am only concerned to draw conclusions from the analogue, and on that basis I now attempt to show that Stokes's postulates are equally inadmissible, whatever finite value be attached to $\mathbf{U}$.

In the flexural analogue of the complete equation (4), the transverse loading in (6) is given by:

$$Z(x,y) = [(\partial w/\partial y).\partial/\partial x - (\partial w/\partial x).\partial/\partial y]\nabla^2 w/\nu \quad (9)$$

and the total moment (about Ox) which it imposes on the plate is given by:

$$\text{(say) } L_Z = \iint y.Z(x,y)\,dx\,dy$$

$$= \frac{1}{\nu}\iint y\left[\frac{\partial}{\partial x}\left(\frac{\partial w}{\partial y}.\nabla^2 w\right) - \frac{\partial}{\partial y}\left(\frac{\partial w}{\partial x}.\nabla^2 w\right)\right]dx\,dy \quad (10)$$

according to (9), when the integral relates to the whole area. From (10), using Green's transformation, we derive:

$$\nu L_Z = \mathrm{U}\oint\left[l\left\{y\frac{\partial w}{\partial y}.\nabla^2 w + \frac{1}{2}\left(\frac{\partial w}{\partial x}\right)^2 - \frac{1}{2}\left(\frac{\partial w}{\partial y}\right)^2\right\} - m\left\{y\frac{\partial w}{\partial x}.\nabla^2 w - \frac{\partial w}{\partial x}.\frac{\partial w}{\partial y}\right\}\right]ds \quad (11)$$

the line-integral extending to the whole perimeter; and the inner (circular) boundary makes no contribution, since at every point of it $\partial w/\partial x = 0 = \partial w/\partial y$. Suppose, now, that on the outer boundary $\partial w/\partial x = 0$ and $\partial w/\partial y = \mathrm{U}$ (as the analogues of (1) require). Then (11) reduces to:

$$\nu L_Z = \mathrm{U}\oint ly.\nabla^2 w\,ds \text{ for the outer boundary.} \quad (12)$$

This is equal to zero if in addition (imposing Stokes's postulates) we require $\nabla^2 w$ (the analogue of $-\zeta$) to be strictly zero at all points of the outer boundary. The transverse loading then contributes no resultant moment to oppose the couple 'clamping' the inner boundary, so the foregoing argument continues to apply (at least for all finite values of the Reynolds number).

So far as I am aware, no exact solution of (4) has yet been found in which the Reynolds number is not zero. But the argument given here does not require the solution of (6) to be known: it merely presumes the existence of some solution, and shows that this cannot satisfy Stokes's postulates, although almost certainly, when the fluid field is very large, ζ takes very small values on its outer boundary. This, then, appears to be an instance in which more than normal gain accrues from an 'argument by analogy'.

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Trumpington,
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March 3.

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Sub-audible Geomagnetic Fluctuations

An investigation has recently been started to examine the natural electromagnetic background in the somewhat neglected frequency range of 0·1–30 c./s. At the high-frequency end of the interval this follows up the work of Menzel and Salisbury[1], of Willis[2] and of Goldberg[3]; and extends the work of Duffus and Shand[4] at the Pacific Naval Laboratory, in the range 1,000–10 sec. period.

The object of this communication is to report that oscillations of the electromagnetic background of about 10^{-7} oersted/sec. in this frequency range are readily recorded directly on magnetic tape traversing at 0·015 in./sec. The energy spectrum is obtained by playing back at 15 in./sec. into conventional filter systems. A 10-in. reel of tape used in this manner lasts about three weeks.

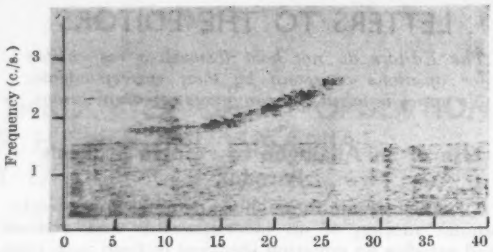

Fig. 1. Rising whistle

In this investigation, we are measuring the electromotive force induced into air-core (or mumetal core) coils. We have a fairly complete record of the rate of change of vertical magnetic field since the end of July 1957 in a horizontal air-core coil of 20 ft. diameter and about 1,000 turns. This is fed into a chopper pre-amplifier, the output of which is recorded on magnetic tape. The output may be monitored on a Brush recorder. Severe difficulties have as usual been encountered in filtering out the power-line frequency and its harmonics.

Since July, several magnetic storms have been recorded. While the spectra have not yet been analysed completely, we have observed several interesting features by playing back at 1,000 times the tape speed of recording. This technique shifts the low frequencies into the audible range and gives a most impressive sound record. Whistles rising or falling in tone, and lasting for many minutes on the original record, are heard especially during magnetic storms. Falling whistles appear to be more usual during quiet times, although both rising and falling whistles occur during disturbed times. Fig. 1 is a vibrogram of a whistle rising from 2 to 3 c./s. Fig. 2 is a photographic record of a part of a lower-frequency whistle. These may be the oscillations 'en perles' reported by Mme. Troyičkaya[5] from ultra-high-speed magnetograph records. Several types of 'transients', lasting about a minute have been recognized. They are probably man-made, but we have not yet eliminated the possibility that some are associated with magnetic storms.

During storm times all frequencies within the range of our investigation can be recorded, but in quiet magnetic intervals the periods of geomagnetic contribution are seldom shorter than the usual daytime oscillations (*PC*) of about 10–20 sec. period.

A subsidiary (remote) station was set up temporarily about two hundred miles away from the main station near Victoria, British Columbia (both in magnetic latitude about 54° N.), and showed no phase shift of the normal daytime oscillations (*PC*) within the limit of our timing during this experiment. However, when small disturbances of higher frequency appeared on both records, it was

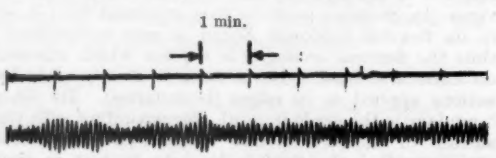

Fig. 2

not easy to identify which turning points corresponded on the two records. No magnetic storms were recorded while both stations were in action.

It is intended to extend this work with two stations, moving the portable station to greater distances in about the same magnetic latitude until the phase differences are such that corresponding peaks cannot be identified. This should give some indication of the distance from the originating disturbance and its extent.

Plans for the future include the recording of rate of change of all three magnetic elements by frequency modulation on a seven-channel tape recorder, which will permit us to record at the same time earth currents and vertical electric potential changes.

This work is supported by the Defence Research Board of Canada, and was carried out at the Pacific Naval Laboratory.

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British Columbia. Jan. 23.

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The Impulse Break-down Characteristic of a Point-Plane Gap in Air

An investigation was carried out to determine the impulse break-down voltage characteristic of a point-plane gap in air at a high altitude of about 6,000 ft. above sea-level, first, in order to confirm the correction for pressure and secondly to determine the influence of the duration of the impulse wave on the break-down characteristic with both polarities.

The million-volt impulse generator used at the University of the Witwatersrand has ten stages each of capacitance 0·054 microfarad. By measuring the charging voltage across the first stage with an electrostatic voltmeter, a reading of the peak impulse voltage of the complete generator was obtained by multiplying the charging voltage by the number of stages. This reading was calibrated against a sphere-gap voltmeter consisting of spheres 100 cm. in diameter.

The break-down voltage was taken to be the peak voltage of the wave for which 90 per cent break-down occurred, namely, that voltage at which break-down of the gap will occur for 90 per cent of the applied impulses. Since the range between no break-down and regular break-down (100 per cent break-down) was approximately 10 per cent of the applied voltage for the range of voltages measured, a large number of impulses was required for a set of readings because break-down in the transition range is statistical. The most convenient way of taking the readings was found to be to trigger the impulse generator a number of times at each suitable voltage step in the transition range, with a constant gap-length. Hence the percentage break-down for each step was calculated from which a graph of percentage break-down against applied voltage was plotted. From these graphs the 90 per cent break-down voltages for the different conditions were extrapolated.

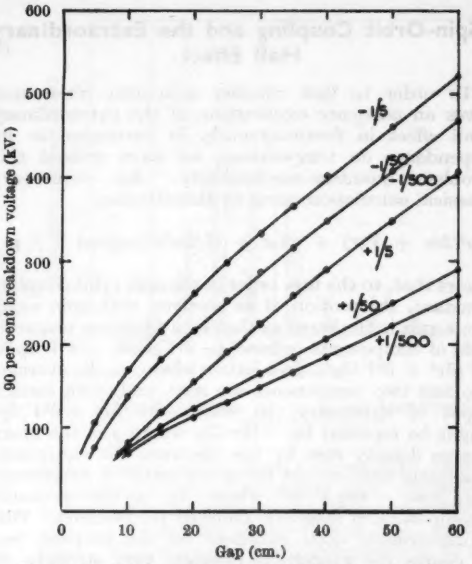

Fig. 1. Breakdown voltage characteristic of a point-plane gap in air at a pressure of 62·5 mm. of mercury, temperature, 25° C., and humidity, 5 gm. water/m.³ air

The values obtained were also corrected for variations in pressure, temperature and humidity to the average values, which were found to be 62·5 cm. of mercury, 25° C. and 5 gm./m.³ respectively. This correction never amounted to more than 2 per cent.

The results are shown in Fig. 1, where the 90 per cent break-down voltage is plotted against gap-length, and also in Table 1. Readings were taken for wave-tail durations to half value of 500, 50 and 5 μsec., one set of readings with the point positive and the other with the point negative.

Table 1. 90 per cent break-down voltage (kV.)

Gap (cm.)	Positive point			Negative point	
	1/500	1/50	1/5	1/500 1/50	1/5
5				75	105
10	69	74	82	137	169
15	94	100	117	181	215
20	112	122	154	216	261
25	130	144	190	252	298
30	148	165	224	286	332
35	166	186	258	315	365
40	184	207	289	348	400
50	222	249	348	408	460
60	258	290	407	467	520

If the altitude correction of 0·82 is applied, the results show good agreement with those given by Meek and Craggs[1]. Comparison with other previous investigations reveals reasonably good agreement for the positive point but an appreciable difference for the negative polarity[2].

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Spin-Orbit Coupling and the Extraordinary Hall Effect

In order to find whether spin-orbit interaction gives an adequate explanation of the extraordinary Hall effect in ferromagnetics, in particular in its dependence on temperature, we have treated this problem quantum-mechanically. An elementary classical calculation using as Hamiltonian

$$p^2/2m + V(r) + e\mathbf{E}.\mathbf{r} + (1/2m^2c^2)\mathbf{s}.(\text{grad } V \wedge \mathbf{p})$$

shows that, to the first order in the spin orbit coupling constant, the motion of an electron with spin along the z-axis is the same as that in a fictitious magnetic field of components $(s/2emc)\,(-\partial^2V/\partial x\partial z, -\partial^2V/\partial y\partial z, \partial V/\partial x^2 + \partial^2V/\partial y^2)$. In a lattice where, on the average, the first two components are zero, and, with certain types of symmetry, in which $\partial^2V/\partial x^2 + \partial^2V/\partial y^2$ might be replaced by $-(8\pi/3)\rho$ where ρ is the mean charge density met by the electron, the equivalent 'magnetic field' would be of the order of magnitude $4\pi s\rho/3emc = 4\pi\rho M/3c^2$ where M is the probable z-component of magnetic moment per electron. This is numerically quite sufficient for the purpose, but of course the magnitude depends very strongly on the path of the electron which governs the values of ρ which it meets.

Qualitatively the term proportional to $\mathbf{s}.(\text{grad } V \wedge \mathbf{p})$ which occurs as part of the potential energy in the Schrödinger one-electron wave equation can be interpreted as follows. Suppose that the primary current is in the direction of the x-axis and that we consider spin eigenstates of the electron parallel and antiparallel to the z-axis. If we consider the variation of potential energy with y in the neighbourhood of a row of lattice ions parallel to the x-axis along, say, the line $y = z = 0$, and call regions I and II those regions near the xy plane for which y is respectively positive and negative and not greater than half the distance between neighbouring rows of ions, then, for electrons in the $\frac{1}{2}+\hbar$ eigenstate of s_z, this term in the potential energy is negative in region I and positive in region II. Provided that the square of the modulus of the electron wave function is greatest in the neighbourhood of the ions rather than in the region half way between them, the dynamic effect of this addition to the potential energy is very similar to that of the potential energy due to an electric field parallel to the y-axis. The transverse field serves to compensate for this effect and to annul current flow in the direction of the y-axis.

In a more detailed quantum mechanical treatment we have used the expansion of a one-electron wave-function in terms of Bloch functions. The coefficients in this expansion vary from their initial values in a manner determined partly by the applied electric field and the spin-orbit coupling. These coefficients can be used to evaluate the quantum-theoretical current density and also to find the distribution function[1], modified as it is by the presence of the electric field and the spin-orbit coupling.

The initial states of the electrons we have chosen as a superposition of s- and d-states with random initial phases in which the d-states have a spin distribution in accordance with the magnetization. The resultant current distribution is obtained by supposing that the probability of a time t elapsing between successive collisions with the lattice is proportional to $\exp(-t/\tau)$, the collision time, τ, being, of course, dependent on temperature.

It is found that only interband matrix elements of the spin-orbit coupling contribute to the effect. The result contains as a factor the square of the resistivity. This is simply a consequence of the fact that the equations:

$$J_x = \sigma_{xx}E_x + \sigma_{xy}E_y, \quad J_y = \sigma_{yx}E_x + \sigma_{yy}E_y$$

connecting current $\mathbf{J}$ and electric field $\mathbf{E}$ give, when $J_y = 0$, $E_y/J_x = -\sigma_{yx}/(\sigma_{xx}\sigma_{yy} - \sigma_{xy}\sigma_{yx})$. Since the second term in the denominator is much smaller than the first, and since we may for many lattices put $\sigma_{xx}\sigma_{yy} = \sigma^2$, we obtain the factor $(1/\sigma^2)$, that is to say, the square of the resistivity. Karplus and Luttinger[2] also obtained this factor unavoidably by considering $E_y = 0$, $J_y \neq 0$, which, strictly speaking, is not the condition realized experimentally. However, in our result another factor occurs which is dependent on temperature. It can be evaluated with reasonable suppositions about the electronic wave-functions, but depends on these and, of course, on the nature of the lattice. We are making numerical estimates of this second term and hope to publish the complete account elsewhere.

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Birefringence Determination in Objects of Irregular Cross-sectional Shape and Constant Weight per Unit Length

The compensation method of obtaining the birefringence of an object seen in a polarizing microscope requires the evaluation of the optical path-difference produced by a known thickness. In elongated objects of irregular cross-sectional shape, for example, silk and viscose rayon filaments and fibres or filaments containing cavities, the thickness at a given point of compensation within the object cannot readily be determined[1,2]. The purpose of this communication is to describe a technique that has overcome this difficulty.

It is known that by means of a compensator suited to the optical character of the object and capable of producing an increase of path-difference across the field of view, a birefringent object can be contoured by fringes, the sharpness of which is similar to that obtaining in two-beam interference. It has been shown[3,4] that by employing a modified photographic technique an appreciable sharpening of two-beam fringes can be obtained; Fig. 1 illustrates

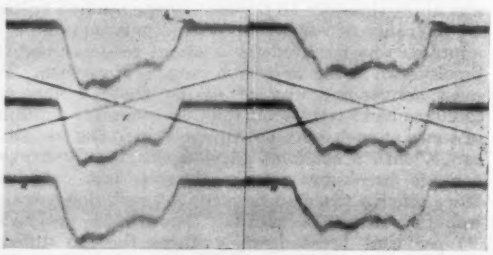

Fig. 1

the application of this technique to industrial viscose rayon filaments contoured by the fringes produced by a Babinet compensator with sodium light.

In such a view, the area (F) enclosed by the deviation of a fringe as it crosses the filament represents the path-difference integrated across the filament. The birefringence is derived from the relation,

$$\mu_1 - \mu_2 = \frac{\lambda F}{SMA}$$

The linear magnification (M) is determined by conventional means; the fringe spacing (S) can be measured in the photograph. The cross-sectional area (A) of the object can be obtained in various ways; for textile fibres it can be derived from values of density and weight per unit length.

For a number of viscose rayon filaments taken from an industrial yarn, a birefringence value of $0{\cdot}023_5$ was obtained by the Becke line method, and $0{\cdot}023_3$ by the technique described here. It is thought that this technique may also be employed to measure changes in optical path difference that occur when the object is mounted in a series of liquids, as is done in the study of the Weiner effect.

I wish to record my appreciation of the assistance given by my colleague Mr. B. Farrow.

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Mass-Spectrometric Observations of Ions in Hydrocarbon Flames

Many investigations have indicated that in the reaction zone of premixed hydrocarbon flames there is a very high concentration of ionized particles, so much so that the conductivity of the zone has been used to locate accurately its position[1,2]. The nature and origin of the ions has, however, remained obscure, since the concentration is too large to be a result only of thermal ionization.

We have constructed an apparatus which is capable of sampling continuously into a low-pressure chamber the products of a suitable flame, which burns at atmospheric pressure. Ions are extracted from the sample and directed into a mass-spectrometer, thus enabling the mass spectrum of the flame ions to be discovered. The initial results cast considerable light on the problem of these ions in hydrocarbon flames.

For the most part, the ions are those of hydrocarbon molecules and radicals, which are evidently formed by very rapid polymerization of the fuel in the pre-heating zone of the flame. Ions have been detected with mass numbers up to 150. The extent of polymerization appears greatest for the unsaturated fuels acetylene and ethylene, as compared with ethane and methane. The rate of decay of these components of high molecular weight is interesting,

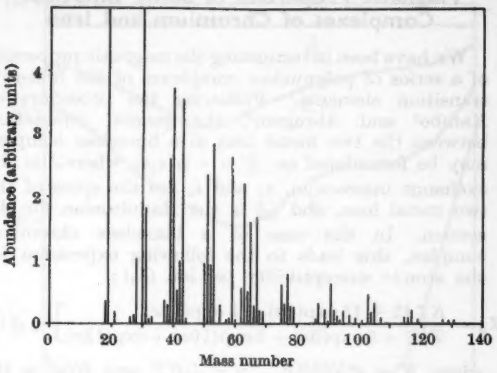

Fig. 1. Ions in reaction zone of an acetylene/nitrogen/oxygen flame ($\lambda = 0{\cdot}8$)

being very rapid in lean (oxygen-rich) flames, and decreasing as the fuel/oxygen ratio increases. For flames fairly fuel-rich, their presence may be detected over an appreciable proportion of the height of the flame. This suggests that polymerization of the fuel may also be the answer, in premixed hydrocarbon flames, to the perplexing question of the mode of formation of solid carbon particles, when these flames contain sufficient fuel to become 'luminous'.

The form of a typical mass spectrum of the ions from the reaction zone of an acetylene/oxygen/nitrogen flame (mixture strength, $\lambda = 0{\cdot}8$) is shown in Fig. 1. The temperature of the burnt gases is about 2,500° K.

Examination reveals that the peaks are grouped around mass numbers corresponding to ions $C_nH_n^+$, with n taking values from 3 to 10. In all these groups there is a markedly increased abundance of ions at the odd mass numbers, indicating greater stability of ions with an odd number of hydrogen atoms.

Peaks which fall outside this scheme (59, 43, 37 and lower mass numbers) are thought to arise from other types of ion, mostly containing oxygen atoms. Mass number 18 almost certainly arises from H_2O^+, and 19 and 21 from $(H_3{}^{16}O)^+$ and $(H_3{}^{18}O)^+$ respectively, these ions occurring also in hydrogen flames. In these flames at atmospheric pressure, there is no indication of ions with one atom of carbon, as has been reported for acetylene flames at 50 mm. pressure[3].

In view of the interest centred at the present time on these problems of combustion, and the directness of the evidence obtained here, it has been thought desirable to publish these findings at once. The results and conclusions of a more extensive investigation will be published elsewhere.

We wish to thank the Research Laboratory of the General Electric Co., Schenectady, New York, for financial support.

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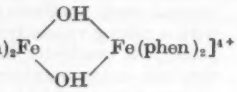
Magnetic Properties of Some Binuclear Complexes of Chromium and Iron

We have been investigating the magnetic properties of a series of polynuclear complexes of the first-row transition elements. Following the procedure of Kambe[1] and Abragam[2], the general interaction between the two metal ions in a binuclear complex may be formulated as $\mathcal{H} = -2Js_1s_2$, where J is the exchange interaction, s_1 and s_2 are the spins of the two metal ions, and $\mathcal{H}$ is the Hamiltonian for the system. In the case of a binuclear chromium complex, this leads to the following expression for the atomic susceptibility per ion (χ_a):

$$\chi_a = \frac{K}{T}\left[\frac{42 + 15\exp(6x) + 3\exp(10x)}{7 + 5\exp(6x) + 3\exp(10x) + \exp(12x)}\right] + N(\alpha)$$

where $K = g^2N\beta^2/3K$; $x = J/KT$ and $N(\alpha)$ is the high-frequency contribution to the susceptibility. Fig. 1 shows the calculated and experimental curves, for the susceptibilities of two such chromium complexes, between liquid-nitrogen and room temperatures. The value of K was taken such that $N(\alpha)$ was about 50×10^{-6} c.g.s. units as, from spectral measurements, the nearest quartet-level for which interaction could occur was of the order of 15,000 cm.$^{-1}$. The values of J, g and $N(\alpha)$ obtained are contained in Table 1. These values are of a similar order to those obtained by Kambe[1] in the interpretation of Welo's data on some trinuclear complexes of chromium. The increase in interaction in the mono-bridged complexes may be due to the fact that the metal–oxygen–metal angle is not restricted, as in the diol.

A similar treatment may be applied to binuclear complexes of ferric iron. Two such complexes in this class are:

$[Cl_3FeCl_2FeCl_3]^{3-}$ and 

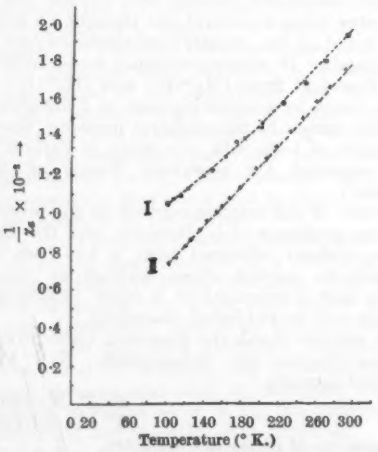


Fig. 1. Curve I: ○, Erythrochloride; ×, erythrobromide; – – –, calculated curve.

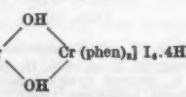
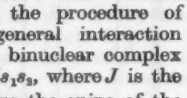
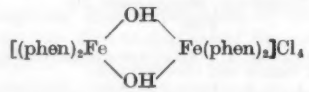
Curve II: ×,  ; – – –, calculated curve

Table 1

Compound	J (° K.)	g	$N(\alpha) \times 10^6$ erg.
Acid rhodobromide	−20·25	1·92	62
Acid erythrobromide and chloride	−20·7	1·97	56
	−10·0	1·97	58
$[C_5H_5N]_3[Cl_3FeCl_2FeCl_3]$	−1·7	2·07	0

(phen = 1 : 10-*ortho*phenanthroline). For the binuclear chloro-bridged complex, agreement between theoretical and experimental curves (Fig. 2) may be obtained by assuming an interaction $J = 1{\cdot}7°$. The only well-established binuclear complex of iron, containing three bridging groups, is iron enneacarbonyl, $Fe_2(CO)_9$. The magnetic properties of this complex indicate that pairing of the spins of the iron atoms takes place; X-ray crystallographic work[3] also indicates that the iron–iron distance is short. However, in the ion $[Cl_3CrCl_2CrCl_3]^{3-}$, the structure of which has recently been established[4], the metal ions move away from each other, giving a large metal–metal distance, and in accord with this the magnetic moment of the complex at room temperature is found to be 3·82 Bohr magnetons. From these magnetic data the bridge chloro-complex of iron would be considered to have a similar structure to the bridged chloro-chromium complex, and we would anticipate that the metal–metal distance was large.

Previous determinations on the complex



were carried out at room temperature, and values of 2·41 (ref. 5) and 1·61 (ref. 6) were obtained. The variation of the susceptibility with temperature is

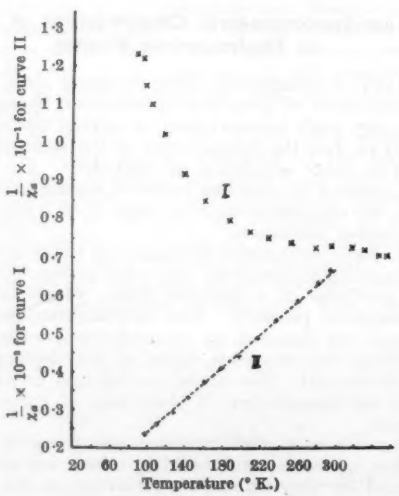
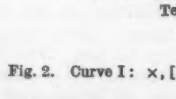


Fig. 2. Curve I: ×,  ; Curve II: ×, $[C_5H_5N]_3[Cl_3FeCl_2FeCl_3]$; – – –, calculated curve

shown in Fig. 2. The susceptibility of the complex is found to show a considerable divergence from the Curie–Weiss law and may be interpreted on the basis of a very high exchange interaction of a similar order to that observed by Figgis and Martin[7] in cupric acetate monohydrate. The main features of the curve may be calculated with a J-value of about 200° K., but this involves a very high value for the $N(\alpha)$ term. From spectral measurements there appears to be no energy-level sufficiently low to account for this, and if the high value of $N(\alpha)$ is correct it would be attributed to a mixing of levels arising from spin-orbit interaction, similar to that found[8] for $K_3[Fe(CN)_6]$. We are investigating this complex over a more extended temperature-range to see if this is possible. The full details of this work will be published elsewhere.

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A Colour Reaction for Non-Ionic and Amphoteric Soaps

The ability of colloidal electrolytes to change the colour of oppositely charged dyes is well known. One of the earliest systematic studies was that of Hartley[1], and later Harkins and others showed that the colour change could be used to observe micelle formation[2]. Similar colour changes can sometimes be caused by non-ionic soaps in solutions of ionized dyes of either charge, but a more striking effect is found with some non-ionic soaps and certain xanthene dyes in the undissociated form. Instead of the usual band shift of between 10 and 20 mμ to the red, there is a more or less complete removal of the main absorption band and discharge of visible colour. Discharge also occurs if water-miscible organic solvents are added, or if the dye is dissolved in the pure solvent.

We wish to report the effect obtained with fluorescein and its dichloro (*R*) derivative. Fig. 1 shows the absorption spectrum of 10^{-4} *M* fluorescein in 0·015 *M* acetic acid, with the changes caused by the addition of 0·25 per cent of a typical non-ionic soap (Shell *TP* 7143) or of 20 per cent acetone. Also shown is the complete absence of absorption in pure acetone. Although with the aqueous acetone there is a slight band shift, the main effect is a discharge of the colour as though the absorbing species itself was destroyed. Dichlorofluorescein behaves similarly, though the control solution has to be weaker because of the greater tendency for the dye to precipitate. Possibly for this very reason dichlorofluorescein shows the effect rather more readily than the parent dye. Substances able to discharge the colour of dichlorofluorescein are listed in Table 1; they include both simple compounds and soaps. Their

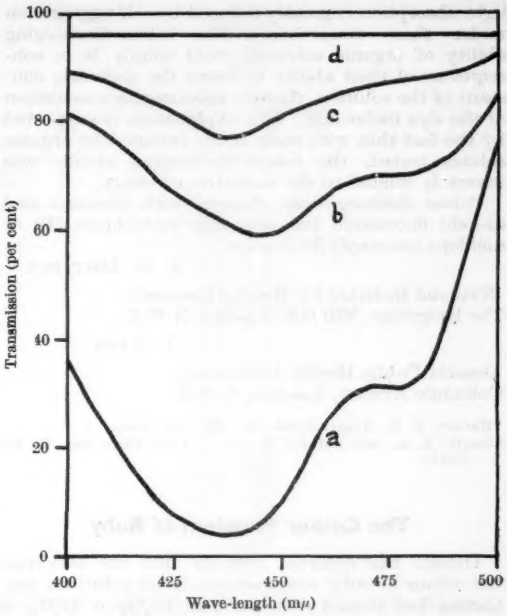

Fig. 1. Transmission of 10^{-4} *M* fluorescein, 1-cm. cell: (*a*) in 0·015 *M* aqueous acetic acid; (*b*) as (*a*), with 20 per cent acetone; (*c*) as (*a*), with 0·25 per cent non-ionic soap; (*d*) in acetone

effectiveness is shown in terms of the concentration required to reduce the absorption of 25 μ*M* dichlorofluorescein at 490 mμ to half the value in 0·015 *M* acetic acid alone. Table 1 shows that some non-ionic soaps, and the phospholipids lecithin and sphingomyelin, have a very much higher activity in this reaction than have the simple solutes. Non-ionic soaps in which the hydrophilic portion was a sugar, for example, saponin and sucrose dilaurate, were not so active. The amphoteric soaps, phosphatidyl ethanolamine and hexadecyl glycine were also of low efficiency, while polyvinyl alcohol was almost completely inactive. In view of the scarcity of simple and direct methods for the analysis of non-ionic soaps and phospholipids, the reaction might form the basis of an analytical method.

A possible explanation of the effect follows from the fact that the undissociated dyes are very sparingly soluble in water, for example, 10^{-4} *M* fluorescein solution, in spite of its apparent stability, was 25-fold supersaturated. The dyes may therefore be expected to concentrate at the surface of at least some kinds of micelle, and it is only necessary to assume that the

Table 1. Concentrations of Organic Solutes needed to suppress the Light Absorption of Dichlorofluorescein by One-Half, measured at 490 mμ

Solute	Concentration (per cent)	Solute	Concentration (per cent)
Glycerol	47	Polyethylene glycol (mol.wt.600)	0·4
Glycol	40	Polypropylene glycol (mol.wt.425)	0·1
Methanol	32	Pluronic *L*62	0·02
Ethanol	21	Macrocyclon	0·003
n-Propanol	13	Lecithin	0·025
Acetone	11·5	Sphingomyelin	0·03
'Diacetin'	6·3		

Pluronic *L*62 is a block copolymer of polyethylene and polypropylene glycols. Macrocyclon is a polyethylene glycol derivative of a *p-tert.*-octyl phenol-formaldehyde cyclin tetramer.

light absorption is greatly reduced by self-aggregation under these conditions. The colour-discharging ability of organic solvents could simply be a consequence of their ability to lower the dielectric constant of the solution, thereby encouraging association of the dye molecules. This explanation is supported by the fact that with most of the twenty-four organic solutes tested, the colour-discharging ability was inversely related to the dielectric constant.

Colour discharge was observed with dibromo- and di-iodo fluorescein but not with tetrachloro (*P*) or dichloro (succinyl) fluorescein.

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The Colour Problem of Ruby

Orgel[1] has reported recently that the abnormal red colour of ruby compositions (solid solutions containing less than 8 mol. per cent Cr_2O_3 in Al_2O_3) is due to compression of the chromic ions. This conclusion is based on the shift towards shorter wavelengths of the absorption band of the chromic ion, from about 17,000 cm.$^{-1}$ in green chromic oxide to about 19,000 cm.$^{-1}$ in the red rubies. However, Orgel's treatment of this problem is incomplete. This shift of the absorption bands, in fact, takes place gradually as the concentration of chromic oxide is reduced down to 8 mol. per cent (Fig. 1*a*)[2]. The colour of the mixed crystals remains green in varying shades down to 30 mol. per cent of chromic oxide, when it changes gradually to greyish-green, grey, greyish-red and then to bright red which remains stable below 8 mol. per cent[2]. The position of the absorption bands remains almost fixed in the red compositions below this concentration. Thus, it is obvious that this phenomenon of ion-compression takes place gradually and in the green region only. (For convenience, the whole of the green-to-red region above 8 moles per cent Cr_2O_3 has been designated as the green region.) No extraordinary compression of the chromic ion is associated with the critical concentration.

The lattice constants[3] of this system also reveal this phenomenon of ion-compression in the green region (Fig. 1*b*). The lattice parameter, *a*, of the green mixed crystals shows a greater decrease than is proportional to the fall in chromium content. At 8 mol. per cent, *a* decreases almost to the lattice parameter for pure alumina (Al_2O_3). The lattice parameters remain almost unchanged in the red compositions, which is the cause of stabilization of the red colour. However, Orgel's value for the radius of the chromic ion (0·57 A.) in red rubies is incompatible with this fact. The size of the chromic ion in the red solid solutions, in fact, appears to be very close to that of the aluminium ion, Al^{3+} ($r = 0{\cdot}50$ A.). This is supported by the fact that the density[3] rises more steeply in the red compositions up to 8 mol. per cent, because a heavier chromic ion (atomic weight 52) replaces a much lighter aluminium ion (atomic weight 27) without any appreciable increase in volume.

Thus, it is evident that the compression by itself is not the cause of the anomalies observed at the critical point. The compression of the chromic ion reaches its maximum limit at 8 mol. per cent, below which some other electronic phenomenon appears to set in, as is revealed by the inflexion in these curves. This view is supported by the fact that this critical concentration is also associated with other anomalies, for example, in specific heat, thermal expansion, and magnetic susceptibility[2]. These anomalies are similar to those observed at the Curie temperature of magnetic materials and, like them, also take place reversibly at a critical temperature for each composition. The green crystals turn red on cooling and the red ones turn green on heating[3].

The critical concentration associated with the colour change in ruby compositions appears to have the same magnetic significance as the Curie temperature. This new concept of 'Curie concentration' is supported by the fact that the changes in the lattice environments produced by contraction with cooling are similar to those brought about by contraction due to the decrease in the concentration of the bigger chromic ions. However, the expected antiferromagnetism of chromic oxide in the ruby crystals remains masked, because of dilution of the paramagnetic ions.

The chromic ions which show ion-compression differ from the stable aluminium ions only in respect of the uncoupled 3*d* electrons, which are relatively freer to be influenced by external forces. Thus, it appears that the compressibility of the chromic ion involves some adjustments in the free 3*d* electron orbits. It has been shown that this compression reaches its maximum limit at the critical point. I believe that below this critical stage, the free 3*d* electrons gradually get squeezed out of the parent chromic ions into 'satellite' orbits formed through the annular space around them. This electronic catastrophe is responsible for all the anomalies associated with

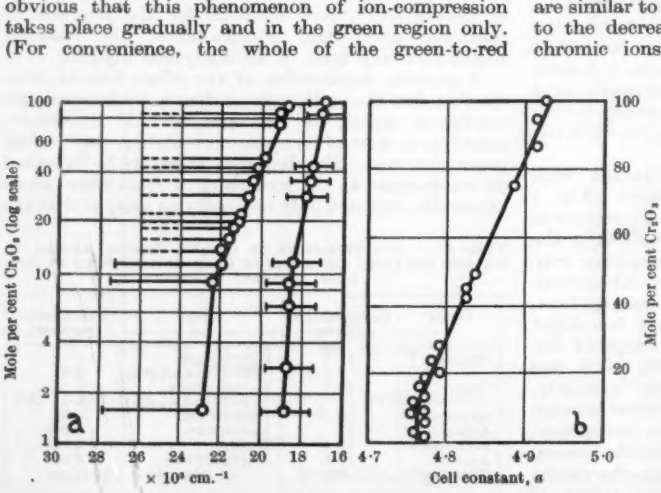

Fig. 1. (*a*) Absorption spectra of $Cr_2O_3 + Al_2O_3$ mixed crystals (after Ritschl and Müller, ref. 2). (*b*) Variation of unit cell constant *a* with concentration (after Thilo *et al.*, ref. 3)

the colour change. This new speculative concept has been described in some detail elsewhere in relation to the magnetic phenomena[4].

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A Robust but Sensitive Detector for Gas-Liquid Chromatography

CHANGES in dielectric constant, the measurement of which is quite non-destructive, have been employed for the detection of gas chromatographic bands while still in the adsorbed state[1]. The method involved the measurement of the change in capacity of a condenser the dielectric of which was either a portion of the column, or a finely divided carbon packing, on which the organic vapour was adsorbed. The technique used, though sensitive, involved the measurement of small changes in radio-frequency employing apparatus of some complexity.

This communication describes a detector of change in dielectric constant (patent applied for) of extreme simplicity, small sensitive volume, robustness and of long linear range. While expressly devised for use on routine preparative columns, it has sensitivity adequate for many analytical applications. The elimination of absorbent packing from the detector cell results in high resolution and speed of response.

The detector cell (Fig. 1) is constructed from a cylindrical brass block, two holes silver plated form the 'earth' sides of the sensing and reference condensers, the 'live' electrodes consisting of silver-plated brass rods supported at their truncated conical ends in silicone-rubber O-rings. The working volume of the detector (here 0·3 cm.³) is capable of at least tenfold reduction for analytical application, where flow resistance is of less importance. The cell is maintained at column temperature by immersion in the same or a subsidiary vapour bath. Incorporation of the two capacitors in the same metal block, however, renders accurate thermostatic arrangements unnecessary.

The circuit for conversion of capacity change to a change of potential (Fig. 2) is a simplified version of that described by Hobday and Alexander[2] and by Sargrove[3]; the essential difference being an improvement in reliability and robustness by reduction in the number of components. Section *A* is contained in a die-cast box attached directly to the detector cell.

A change in the relative resonant frequencies of the tuned circuits L_1C_2 and L_2C_3 is reflected in voltage changes at V_1 anode. Adjustment to the central, steeply sloping part of the sigmoid characteristic curve is made by adjustment in the coils L_1 and L_2 of iron-dust cores, the position of which can be rigidly fixed by locking nuts. Fine adjustment of the zero level is provided by R_{11} (Fig. 2*B*).

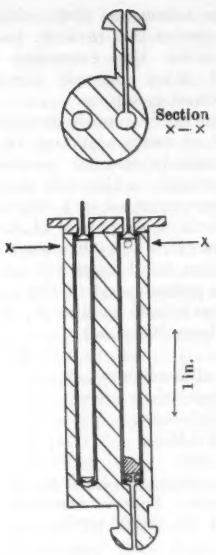

Fig. 1

Extreme rigidity throughout the head unit was found to be essential since flexing of the case or components may result in appreciable capacity changes. To obtain the highest sensitivity, careful electrical screening of the 'sensing' from the 'reference' side of the circuit was also found to be essential.

The sensitivity to different materials varies with the dielectric constant ε of their vapours. Thus acetone (ε, 1·026), and diethyl ether (ε, 1·007) were detected at threshold concentrations of 2 and 8 μgm./cm.³ respectively in a nitrogen gas-stream. (Threshold

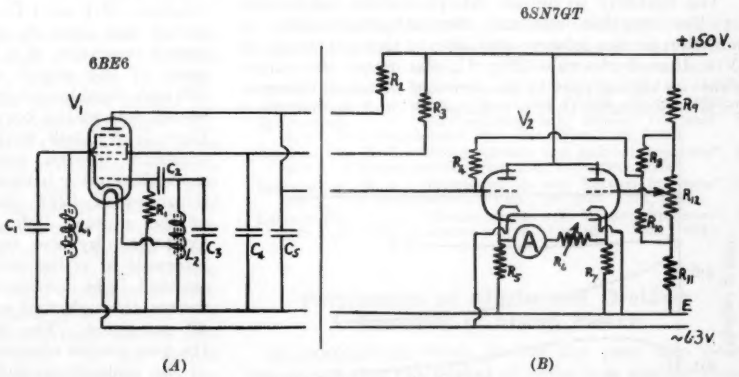

Fig. 2. Component values:

R_1	47,000 ohms	½ W.		C_1	Sensing cell
R_2	0·5 megohm	½ W.		C_2	20 pF. silvered mica
R_3	33,000 ohms	½ W.		C_3	Reference cell
R_4	50 megohms	½ W.		$C_{4,5}$	1,000 pF. moulded mica
$R_{5,7}$	10,000 ohms	1 W.		L_1	11¼ turns ⅜ in. dia. 28 S.W.G. close spaced
R_6	0–10,000 ohms	½ W.		L_2	Ditto, cathode tap 3½ turns from earth end
$R_{8,10}$	4,700 ohms	½ W.		V_1	6*BE6*
R_9	0·1 megohm	½ W.		V_2	6*SN7GT*
R_{11}	50,000 ohms	½ W.		A	0–500 microammeter
R_{12}	0·1 megohm, variable				

concentration is taken as that which produces a signal equal to twice the random background fluctuations.) Between the extremes of these two compounds fall most organic compounds which contain a functional grouping.

The instrument is completely insensitive to changes in rate of flow of carrier-gas up to 500 cm.³/min. (the highest studied) and to pressure changes up to 10 cm. of mercury in the case of nitrogen. With the twin-chamber detector cell described, long-term drift (after a warming-up period of 30 min.) is absent at the sensitivity (R_s = 10,000 ohms) which results in full-scale deflexion for 1 mgm. of acetone per cm.³. The intrinsic response speed of the apparatus (meter excepted) is determined by the V_1 anode lead filter time constant (here 500 μsec).

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Relative Instability of Chlorpromazine in *N* Alkali

In the course of study of the factors responsible for the low recoveries of chlorpromazine from brain tissue, it was observed that *N* sodium hydroxide, which is commonly used in the extraction procedure[1,2], caused singular changes which could be followed spectrophotometrically. Readings at 2550 A., an absorption peak characteristic of chlorpromazine, steadily decreased with time, accompanied by immediate increased readings at 2750 A., which is characteristic of the sulphoxide[2]. These latter readings reached a maximum within 10–15 min., and began to decrease progressively, indicating further changes in the molecule (Fig. 1). No such changes were evidenced in 0·05 *N* sodium hydroxide (final concentration).

The inability to detect chlorpromazine sulphoxide in the reaction mixture chromatographically, in addition to the relative stability of this substance in *N* sodium hydroxide (Fig. 1), eliminates the sulphoxide as taking part in the series of chemical changes. It is conceivable that a reduced thionol derivative is formed, for these compounds also are known to have a maximum absorption in the neighbourhood of 2750 A. The ease with which this transformation occurs is of interest in connexion with the metabolism of the drug.

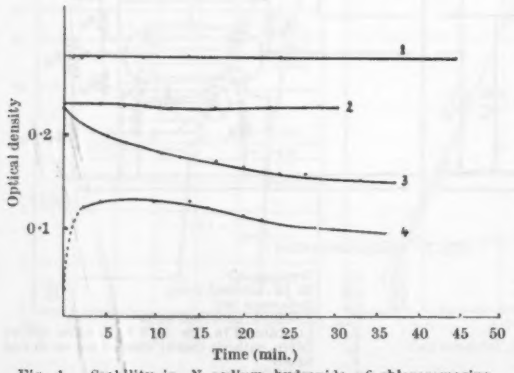

Fig. 1. Stability in *N* sodium hydroxide of chlorpromazine sulphoxide at: (1), 2550 A.; (2), 2750 A.; and of chlorpromazine at: (3), 2550 A.; (4), 2750 A.

Whereas the decomposition of chlorpromazine in *N* alkali cannot account quantitatively for the poor recoveries from brain, it does point to the need for better control of *p*H when the extraction is made into organic solvents. We have used *p*H 10·0 with satisfactory results.

Furthermore, these studies also suggest that the comparative stabilities of chlorpromazine and its sulphoxide in *N* sodium hydroxide may be used as a means of differentiating the two substances.

We are grateful to Smith, Kline and French Laboratories for a gift of chlorpromazine and its sulphoxide. This research is supported by a grant from the Psychiatric Training and Research Fund, Illinois Department of Public Welfare.

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Action and Emission Spectra of the Luminescence of Green Plant Materials

A study of the spectral characteristics of the delayed light emission of green plant materials has been undertaken. The apparatus used was identical to that reported earlier[1] except that a longer time constant (0·1 sec.) for the photomultiplier amplifier circuit was used in order to integrate noise and to permit operation at a higher gain. For the measurement of the action spectra, a Bausch and Lomb 500 mm. focal length grating monochromator (No. 33–86–45) was placed between the exciting light (General Electric *FT*–503 flashtube) and the sample. The emission spectra were measured by placing the monochromator between the sample and the detector (Dumont *K*–1292 photomultiplier). The intensity of the emitted light, approximately 0·2 sec. after excitation by the flash, was measured at 10 mμ intervals of either exciting light (action spectra) or emitted light (emission spectra). Two curves were drawn through two sets of alternating points taken 20 mμ apart. The final curve was drawn between the two curves obtained in this way. The slit width of the monochromator corresponded to a band pass of about 20 mμ. A correction for the relative number of quanta in each wave-length of exciting light was applied in the action spectra measurements and the emission spectra were corrected for the sensitivity of the photomultiplier at the various wave-lengths from data supplied by the manufacturer of each of these instruments. All curves, except where otherwise stated, were measured using very thin films of material.

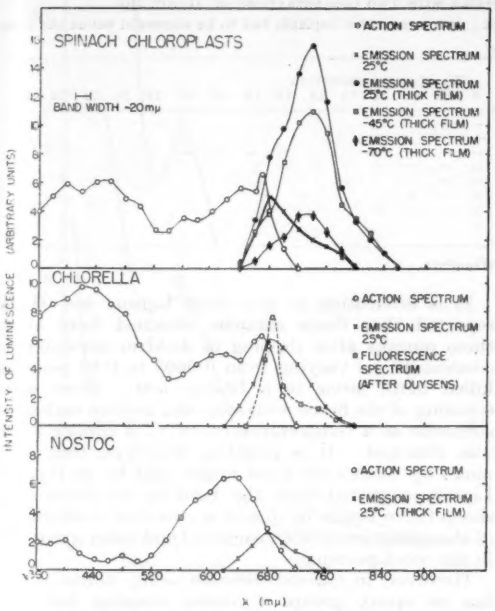

Fig. 1. Action and emission spectra of the delayed light emission of *Chlorella*, *Nostoc* and spinach chloroplasts. The band-width of the monochromator was ~ 20 mμ. The relative heights of all the curves are roughly comparable

The results of these measurements are shown in Fig. 1. The action spectra for the delayed light emission of *Chlorella* and of spinach chloroplasts are quite similar to the absorption spectra of these materials, and show both the chlorophyll and the carotenoid bands. *Nostoc*, on the other hand, has an action spectrum very much different from its absorption spectrum. Both the carotenoids and the chlorophyll are apparently very low in activity. The action spectrum for *Chlorella* is the same as that obtained earlier by Strehler and Arnold[2] while that for *Nostoc* resembles the curve for *Synechococcus*[3], another blue-green alga.

The room-temperature emission spectra of the delayed light obtained from thin films of *Chlorella* and of spinach chloroplasts are essentially identical. A curve for *Chlorella* has been obtained earlier by Arnold and Davidson[4]. For purposes of comparison, a typical fluorescence spectrum of *Chlorella*[5] has been plotted in Fig. 1. The two types of emission are seen to have similar spectra. The fact that the low intensity of the luminescence necessitated the use of rather wide slits in the monochromator accounts for the somewhat broadened shape of the delayed light-emission spectra as compared with the fluorescence spectrum. Thus, the delayed light emission of both *Chlorella*[4] and spinach chloroplasts is the result of a transition between the first excited singlet state and the ground state of chlorophyll. In an earlier publication[1], it was tentatively suggested, on the basis of crude measurements with filters on thick films of material, that the luminescence of spinach chloroplasts was the result of a triplet state to ground state emission of chlorophyll. This is now recognized as having been due largely to the self-absorption distortion of the emission spectrum (see later).

Emission spectra for thick films of spinach chloroplasts at three temperatures are also plotted in Fig. 1. Thick films were used in order to compensate for the low intensity of the low-temperature emissions[1]. The markedly different shape of these spectra, as compared with the thin-film spectra, is due to self-absorption. However, it is apparent that the curves at all three temperatures are identical in shape, thus suggesting that they are the result of the same electronic transition. This independence of temperature indicates that the triplet state of chlorophyll is not involved at all in the delayed light emission of spinach chloroplasts.

The delayed light emission of *Nostoc* is very much weaker than that of either *Chlorella* or of spinach chloroplasts, therefore necessitating the use of thick films of material. In view of this, it would be expected that, if the emission were due solely to chlorophyll, the spectrum would be similar to those obtained with thick films of chloroplasts. However, this is in fact not the case. This suggests that a significant portion of the emitted light originates in phycocyanin (which has a fluorescence peak[6] at about 660 mμ) and is self-absorbed in the thick layer. The *Nostoc* emission spectrum also resembles that obtained for *Synechococcus*[3].

The action spectra for *Chlorella* and for spinach chloroplasts demonstrate that electronic excitation energy may be transferred, with some degree of efficiency, from carotenoid to chlorophyll in these materials. On the other hand, transfer from carotenoid to either chlorophyll or phycocyanin proceeds with much lower efficiency in *Nostoc*. Similar conclusions have been drawn for *Chlorella*[7] and for *Oscillatoria*[8], another blue-green alga, through studies of the photosynthetic and fluorescence action spectra of these organisms.

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Persistence of Aldrin and Dieldrin Residues in Sheep Fleece

EXPERIMENTAL work during the past two years has shown that the period of protection against sheep blowfly strike conferred by aldrin and dieldrin dips can vary from 12 to more than 40 weeks. In Britain sheep dipped in May with dieldrin at a concentration of 0·05 per cent are usually protected against strike for a period of up to 16 weeks. Aldrin is not so widely used in sheep dips, but its protective period at the same concentration is about 12–14 weeks. It has been found, however, that if sheep are dipped in

Table 1. The Period of Protection from Blowfly Strike with Two Concentrations of Aldrin Dip

The sheep were implanted with blowfly larvæ three times per week; two consecutive implants had to be successful before the sheep were considered positive.

Dipping bath concentration (per cent)	Lamb No.	No. of weeks protection 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0·0125	1	–	–	–	–	–	–	–	–	–	+													
0·0125	2	–	–	–	–	–	–	–	–	+														
0·0125	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+				
0·0125	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+								
0·025	5	–	–	–	–	–	–	–	–	–	–	–	–	+										
0·025	6	–	–	–	–	–	–	–	–	–	–	+												
0·025	7	–	–	–	–	–	–	–	–	–	–	–	+											
0·025	8	–	–	–	–	–	–	–	–	–	–	+												

+ Successful implant

aldrin in August sufficient insecticide remains to prevent strike until April or May of the following year—a period of approximately 40 weeks. Little is known about the rate of depletion of insecticide or the factors that bring it about, and the present work was designed to throw some light on this problem.

A detailed examination has been made of the rate of depletion of aldrin on groups of Clun Forest lambs. Regular wool samples have been taken, and the aldrin removed and estimated chemically by a modification of the phenyl azide method[1]. Simultaneously, biological assays, similar in principle to those used by Fiedler and Du Toit[2], have been carried out with wool samples. Weekly implantation of blowfly larvæ on the dipped sheep has been used for determining the end-point of the protective period. From these experiments it has been possible to determine the rate of fall of the concentration of aldrin on the fleece.

The graph in Fig. 1 shows that during the first four weeks after dipping the concentration falls rapidly. This is followed by a much more gradual loss which continues throughout the winter months. Analysis of wool samples from the first season's dipping trials made it possible to determine the level at which a successful strike can occur and these findings are being amply confirmed by this season's work.

This study of the depletion-rate has been correlated with records of weather, rate of wool growth and the movement of insecticide down the fibre.

Variation of the initial dipping-bath concentration within certain limits does not greatly effect the ultimate period of blowfly protection (Table 1). The rapid fall in the concentration of insecticide during the first few weeks after dipping goes some way towards explaining this phenomenon.

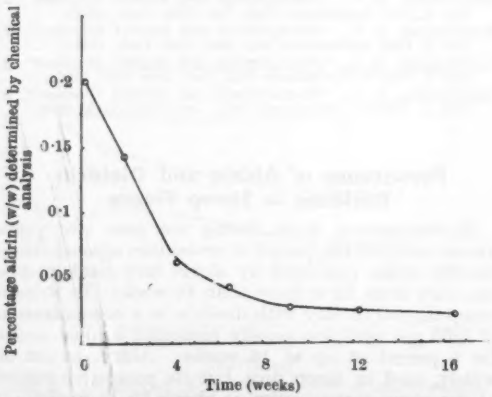

Fig. 1. The rate of depletion of aldrin on Clun Forest lambs dipped in August at a bath concentration of 0·05 per cent

It is interesting to note that Lipson and Hope[3] reported that fleece samples obtained from sheep three months after dipping in dieldrin emulsions of concentrations varying from 0·0005 to 0·01 per cent killed moth larvæ in a 16-day test. Even after scouring of the fleece with soap and sodium carbonate solutions at a temperature of 48° C. a similar result was obtained. It is possible, therefore, that cloth made up from such wool might still be mothproof. Lipson suggested that the tenacity of dieldrin on sheep fleece might be due to a chemical combination of the epoxy group with carboxyl and other groupings in the wool protein.

However, in our experiments using aldrin, which has no epoxy group, a similar tenacity has been noted. From certain samples of wool dipped in 0·05 per cent aldrin it has been found impossible to remove all the insecticide even after several days continuous Soxhlet extraction with petroleum ether. Wool which has undergone this treatment will still kill blowfly larvæ in a 24-hr. test. It would seem, therefore, that there is some combination between the wool fibre and aldrin which, although resisting washing in hot organic solvents, still leaves an insecticide available to larvæ moving over the fibre surface.

Full details of the results and methods used in this work will be published elsewhere.

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A Novel Non-Enzymic Browning Reaction

The enzymic oxidation of polyphenols, particularly in the presence of amino-acids, is well known to be a cause of browning in foodstuffs. The mechanism of non-enzymic browning reactions is, however, still obscure. It is generally believed that non-enzymic browning involves an initial condensation of amino-acids with the active carbonyl group of reducing sugars (the Maillard reaction) or furfuraldehydes derived from sugars or sugar-acids[1]. The condensation product is assumed to undergo further reactions leading to highly coloured, ill-defined materials. The possibility of an initial, direct reaction of some naturally occurring polyphenols with amino-acids as

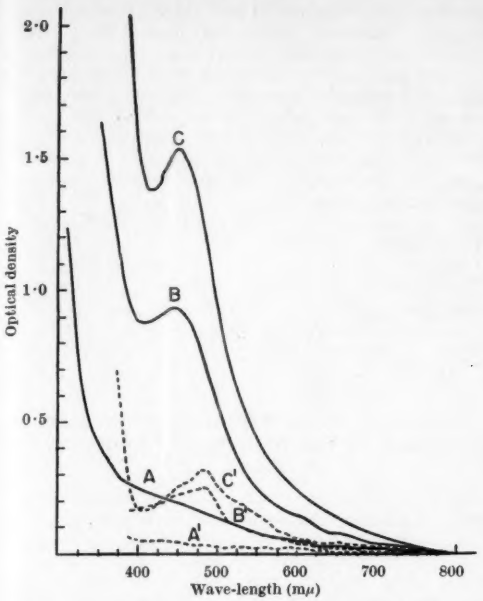


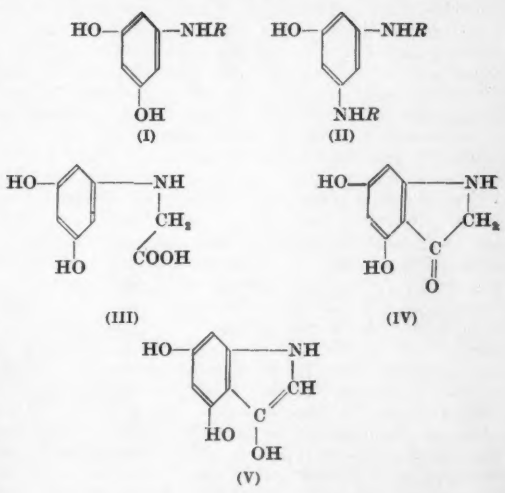
Fig. 1. Visible spectra of phloroglucinol and phloroglucinol–glycine solutions after two weeks standing at *p*H 6, 7 and 8. *A*, *B* and *C*, test solutions of 0·05 *M* phloroglucinol and 0·05 *M* glycine at *p*H 6, 7 and 8. A^1, B^1 and C^1, control solutions of 0·05 *M* phoroglucinol at *p*H 6, 7 and 8

a cause of non-enzymic browning, however, does not seem to have been proposed.

On the basis of qualitative tests, it has been reported that immature green dates contain appreciable quantities (2–3 per cent) of polyphenolic compounds, including phloroglucinol and unidentified flavone pigments[2]. As the dates ripen and become brown, the detectable polyphenol content decreases to almost zero. Since both green and ripe dates contain considerable quantities of free amino-acids[3,4], it occurred to us that the simultaneous development of colour and disappearance of polyphenols might involve a reaction of the latter compounds with amino-acids.

To test this hypothesis a model experiment was carried out in which 0·05 *M* aqueous solutions of phloroglucinol and glycine buffered at *p*H 6, 7 and 8 (Na_2HPO_4/NaH_2PO_4 buffers) were mixed and allowed to stand at room temperature for 2 weeks. After only 24 hr., a striking difference was observed between these and a set of control solutions of the same *p*H range from which glycine had been omitted. While the phloroglucinol–glycine solutions, especially those of *p*H 7 and 8, had developed a distinct brown colour, the solutions with phloroglucinol alone remained almost colourless. Although solutions of phloroglucinol alone, particularly at *p*H 7 and 8, developed some colour on standing, the difference between these and the solutions containing both phloroglucinol and glycine became progressively more pronounced with increasing time. This is clearly illustrated by the visible spectra of test and control solutions after standing 2 weeks (Fig. 1). These absorption curves demonstrate not only the greatly accelerated colour development of the test solutions in comparison to the controls but also indicate a different type of browning reaction for the two series of experiments since the $\lambda_{max.}$ for the darkened phloroglucinol solution is at 483 mμ, while that of the phloroglucinol–glycine system (*p*H 7 and 8) is at 443 mμ.

It was of interest to determine whether other phenols, particularly those which contain ortho-dihydroxyl groupings and are known to be involved as substrates in enzymic browning reactions, behave similarly to phloroglucinol. At *p*H 7 solutions of catechol, resorcinol, eriodictyol and quercetin containing an equimolecular quantity of glycine remained colourless. Solutions of *d*- and *l*-epicatechin, alone or admixed with glycine, developed yellow colours. It is clear, therefore, that of all the phenols examined, phloroglucinol is unique in reacting with glycine under physiological conditions. The fact that quercetin and eriodictyol, both of which contain a combined phloroglucinol nucleus, do not react with glycine indicates that the three hydroxyls of phloroglucinol must be free for reaction to occur, a conclusion which is further substantiated by the non-reactivity of resorcinol. Phloroglucinol exhibits the properties of a triketone. It is well known to react with amines to give colourless products of the types I and II[5]. Although no attempt has been made as yet to define more closely the reaction which occurs between phloroglucinol and glycine, it would seem that condensation (III) followed by cyclization to a 3-hydroxy-indole (IV → V) is entirely feasible. This hypothesis is attractive since an indole, 5,6-dihydroxy-indole-2-carboxylic acid, has been shown to be an intermediate in melanin formation[6].



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Effect of Potassium Cyanide on Apparent Free Space in a Brown Alga

While studying the effect of salt concentration on the respiration of an emergent brown alga *Hormosira banksii*, potassium cyanide was found to have an effect on the apparent free space. When cation analyses were performed on tissue exposed to 10^{-4} *M* potassium cyanide, an increase was observed in the apparent free space over the control value with respect to the sodium ions, this effect being most evident at *p*H 6·0. Experiments have been performed to assess the influence of potassium cyanide on the free space of *Hormosira* using the radioisotopes chromium-51 (as sodium chromate), iodine-131 (as sodium iodide), phosphorus-32 (as orthophosphate) and sulphur-35 (as potassium sulphate).

After a preliminary 4-hr. treatment of the tissue with potassium cyanide in Allen's artificial sea-water with increased potassium ion concentration (potassium is apparently instrumental in inducing the stimulated respiratory response), each bladder used was divided into four equal portions, and the four sets of tissue placed for 60 min. in the labelled sea-water solutions. Each sample of tissue was then transferred to 50 ml. of isotope-free sea-water with increased concentration of the appropriate non-labelled ion for a 'desorption' period of 40 min. Aliquots of these solutions were assayed for radioactivity, either with a standard end-window Geiger–Müller scaling and counting unit (phosphorus-32 and sulphur-35) or an 'Ecko' scintillation counter (chromium-51 and iodine-131). All experiments were performed in duplicate at 20° C., and two aliquots of each 'desorption' solution were counted to at least 5,000 counts (phosphorus-32 and sulphur-35), or 10,000 counts in the case of chromium-51 and iodine-131. Control experiments without potassium cyanide were performed at the same time.

The results obtained are shown in Table 1. It can be seen that both at the lower *p*H and with the addition of potassium cyanide the apparent free space appears to increase, and also that, except for the iodine-131 experiment, the percentage difference between results for control and potassium cyanide data for each isotope is approximately the same irrespective of *p*H. From this and observations on cation distribution it would appear that not only does the volume of the free space alter but also there is an increased number of sites available for the exchange of anions. Butler[1] has obtained consistently higher values for the apparent free space of wheat roots in the presence of 2,4-dinitrophenol which, he suggested, induced a change in the free space itself. Johnson and Bonner[2], however, found that 10^{-3} *M* potassium cyanide decreased by about 45 per cent the amount of 2,4-dichlorophenoxyacetic acid taken up by *Avena* coleoptiles in the initial equilibration period for the free space, and considered that at this concentration potassium cyanide may repress the exchangeable binding of the dichlorophenoxyacetic acid.

Table 1. Apparent Free Space (per cent)

Isotope	*p*H	+ KCN	Control
Chromium-51	6·0	30·6	28·7
	8·0	26·6	24·4
Iodine-131	6·0	48·2	35·4
	8·0	39·5	31·8
Sulphur-35	6·0	37·8	30·5
	8·0	31·9	25·2
Phosphorus-32	6·0	42·4	36·9
	8·0	37·3	30·2

Briggs and Robertson[3] consider that in experiments using the entry of an electrolyte to measure the free space of tissue the estimate may be made more accurately in the presence of cyanide or other inhibitors since the rate of accumulation rises from zero time in a manner at present not fully understood. It can be seen from the results presented that this suggestion is open to some doubt.

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Influence of the Enclosing Protective Tissues on the Metabolism of Barley Grain

Mechanical injury sustained by barley grains during combine harvesting is reflected in their subsequent capacity to germinate and their susceptibility to fungal attack[1]. Since conventional germination tests take at least seven days to complete and difficulties arise due to dormancy of freshly harvested grain, we have sought a more rapid and reliable means of assessing the mechanical damage sustained during harvesting. Our attention was directed to the technique of steeping barley grains in 50 per cent (v/v) sulphuric acid to remove the husk and pericarp, thus overcoming dormancy and obtaining rapid germination[2,3].

Applying the above treatment to freshly harvested dried Proctor barley, it was found that dormancy was overcome satisfactorily, and germination of undamaged grains was unimpaired, but that the germination of combine-harvested samples was markedly reduced if the harvest treatment had been severe[4]. Further testing of a wide range of dried barley samples at intervals over a year of storage has shown that undamaged grains remain immune to adverse effect by the acid, while the germination after acid treatment of samples that had been harvested by combine reflected the severity of the field treatment they had received, this correlation becoming stronger the longer the barley was stored. It was also noted that the removal of the husk and pericarp by the acid rendered grains more subject to fungal attack during subsequent germination[5]. The use of acid of known specific gravity would seem desirable for greater consistency in comparative work than is practicable using the volume/volume solution.

The reduction of germination of mechanically damaged samples is considered to be due to two factors. First, in cases where the testa had been broken the acid attacked the internal tissues of the grain, as had been found to be the case with much weaker acid[6]. Secondly, there was evidence that grains which had been bruised became increasingly permeable to the acid with the passage of time, even though the testa was physically intact.

Our results support the view that it is the testa which acts as a semi-permeable membrane controlling the intake of solutes, while the husk and pericarp are intimately connected with dormancy of barley. Further, Bishop[7] has suggested that fungi on barley grains may secrete enzymes which attack the pro-

tective covering tissues initially, so eliminating delayed germination, before going on to attack and kill the germ; our results show that once the husk and pericarp have been removed the susceptibility of the grains to fungal attack is greatly increased. The presence of sub-epidermal fungi in wheat has been demonstrated by Oxley and Jones[8]; the growth of *Aspergillus restrictus* on both dry wheat and barley has also been demonstrated[9,10]. On these grounds, and on the basis of results obtained to date in testing the viability of combine-harvested barley stored over a number of years, it is concluded that the physical condition and function of the protective tissues enclosing the barley grain determine to a great extent its maximum possible life-span, and the vigour with which its embryo will germinate at any given time within that period.

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Water Relations of Leaves from Woody and Herbaceous Plants

The results of Weatherley and Slatyer[1,2] show that, for a given loss of water, privet leaf disks develop a greater diffusion pressure deficit and suffer a greater fall in turgor pressure (down to zero) than tomato leaf disks. The greater diffusion pressure deficit is due mainly to the higher osmotic potentials recorded in privet[2], as in woody plants in general[3], but a second contributory factor indicated by the greater drop of turgor pressure is a greater mechanical resistance to shrinkage in privet, and this again seemed likely to be a general difference between woody and herbaceous plants. Some comparative observations on changes in volume during loss of water from detached leaves of woody and herbaceous plants have underlined the mechanical difference between them.

Fig. 1 shows the results of an experiment in which five mature leaves of *Euonymus europaeus* L. and of sugar beet were brought to full turgor and then allowed to wilt under constant light, temperature and humidity with hourly determinations of weight, area and volume (by displacement of water). The beet leaves became very flaccid and their volume fell with their loss of water, whereas the volume of the firmer *Euonymus* leaves fell much less relative to their loss of water, implying that here the tissue shrinkage was mainly internal. The estimated volume of the intercellular air spaces in beet shrank faster than the whole leaf, while in *Euonymus* it rose to a peak and was still above its turgid value at the end of the experiment. This contrast in the internal leaf changes was confirmed from direct measurement of the intercellular volume in turgid and wilting leaves, by vacuum injection with benzene, followed at once by weighing in benzene. Observations on

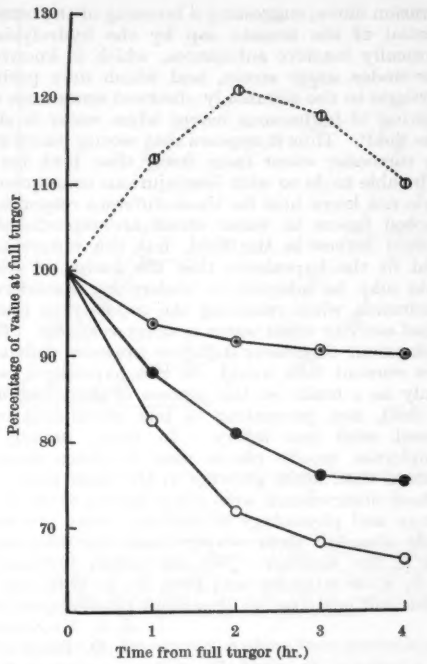

Fig. 1*a*. Changes in area and volume of mature leaves of *Euonymus*, starting at full turgor and losing water for 4 hr., with estimated changes in volume of the intracellular air spaces (obtained by subtracting the cell volume (water content plus dry matter volume) from the total leaf volume. ⊙---⊙, air-space volume; ⊙—⊙, area; ●—●, total volume; ○—○, water volume

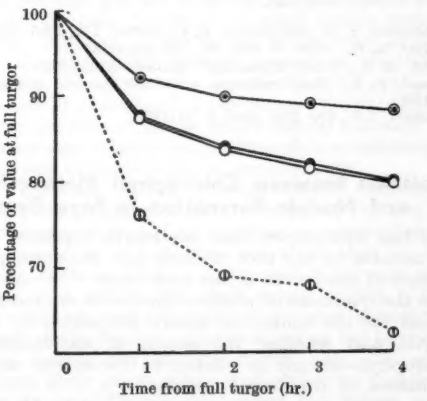

Fig. 1*b*. Similar changes for sugar beet. Key as in Fig. 1*a*

other woody and herbaceous leaves, including poplar, peach, potato and broad bean, have shown similar differences.

A second difference in Fig. 1 (recorded repeatedly) is that the water-loss curve flattened off earlier in the beet leaves, from which it may be inferred that the *Euonymus* leaf stomata remained open at lower leaf-water contents than the beet stomata. Now the osmotic pressures recorded by Slatyer[3] in privet approximated quite closely to the values expected through concentration of the existing solutes alone, down to 32 per cent relative turgidity. By contrast, the osmotic pressures recorded in tomato were markedly in excess of those expected through con-

centration alone, suggesting a boosting of the osmotic potential of the tomato sap by the hydrolysis of osmotically inactive substances, which is known to occur under water strain, and which may perhaps contribute to the commonly observed senescence and withering of herbaceous leaves when water is short in the field[4]. Thus it appears that woody leaves may both surrender water more freely than herb leaves, and be able to do so with less injurious consequences. We do not know how far these different responses of detached leaves to water stress are reproduced in attached leaves in the field, but the observations would fit the hypothesis that the leaves of woody plants may be adapted to undergoing considerable dehydration while retaining the capacity to resume normal activity when water is again available. Their development of greater diffusion pressure deficits as water content falls would, on this hypothesis, serve mainly as a brake on the process of dehydration in the field, not preventing it but permitting it to proceed with less injury. In short, among the mesophytes, woody plants may be more drought-resistant than herbs growing in the same place.

These observations were made during work on the ecology and physiology of aphids[5], many species of which abandon their woody hosts for herbaceous ones in the summer. We are deeply indebted to Dr. P. E. Weatherley and Prof. F. L. Milthorpe for advice and criticism on this plant-physiological side.

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Relation between Chlorophyll Metabolism and Nodule Formation in Soya Bean

It has been shown that day-length regulates both the number of the root nodules and the chlorophyll content of the leaves in the soya bean[1,2]. There now arise the questions of whether the leaves are receptive organs for the control of nodule formation by day-length, and whether the action of day-length on chlorophyll-content is related to its action on the formation of functional nodules.

An experiment has been carried out to elucidate these problems. Soya beans of the variety *illini*, cultivated at a constant temperature of 20° C. (in a phytotron room), under artificial light given by six fluorescent 'Phytor' lamps, 65 cm. from the soil (providing an intensity of illumination of 4,500 lux at the soil surface), are inoculated with a specific strain of *Rhizobium* in the manner previously described[3]. The plants are divided into two sets: one is cultivated in long-day (16 hr.), the other in short-day (8 hr.) conditions. When the second leaf begins to grow, the apex, lateral buds and all other leaves are removed. The plants—having only their very young second leaf—are immediately separated into four series: (1) control plants remaining in 16-hr. day; (2) plants transferred from 8- to 16-hr. day; (3) plants transferred from 16- to 8-hr. day; (4) control plants remaining in 8-hr. day. After thirty days, the number of nodules and their dry-weight are measured. The chlorophyll content of the leaves is estimated in each series after fifteen and thirty days.

Table 1. Effect of Change in Day-length on the Number and the Dry Weight of Root Nodules in Soya Bean, var. *illini*

Day-length	No. of nodules per 100 plants	Dry weight of 100 nodules (mgm.)
(1) Controls in 16 hr.	543	107
(2) Transferred from 8 to 16 hr.	322	81
(3) Transferred from 16 to 8 hr.	354	35
(4) Controls in 8 hr.	42	11

Table 1 shows that the controls grown in long-day conditions produced about twelve times as many nodules as those in short-day conditions. Long-day nodules are also ten times heavier (dry-weight) than short-day nodules. The plants transferred from 8- to 16-hr. days produced many more nodules than controls remaining under 8-hr. days and the nodules of the transferred plants are appreciably heavier than those of the controls. On the other hand, the plants transferred from 16- to 8-hr. days produce fewer nodules than controls remaining under 16 hr., and their average dry-weight is also lower.

It appears that transfer from long- to short-day, or from short- to long-day conditions has an effect on nodulation which, in the circumstances of this experiment, is only explicable if the (second) leaf acts as the receptive organ for the control of nodulation by day-length.

Fig. 1 shows the evolution of the chlorophyll content in the second leaf after change in day-length, the values at the moment of the transfer being taken as 100. The control plants in 16-hr. days accumulate the pigment at a relatively rapid rate, doubling their content in thirty days. It has been shown previously that the rate of accumulation under short days is at first low, but later becomes more rapid[2]. In the transferred series, two distinct regimes are observed. When transferred from short- to long-days, the plants augment their chlorophyll content very rapidly up to four times the initial value. On the other hand, in plants transferred from long- to short-days, accumulation practically stops.

Comparing these results with those for nodulation, it appears that, especially in the transferred series, nodulation proceeds parallel to the accumulation of pigment. A very rapid accumulation of pigment in

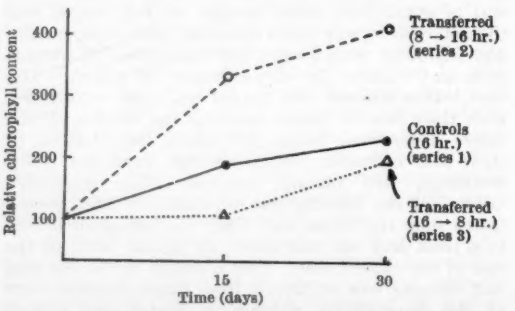

Fig. 1. Effect of transfer from one day-length to another on chlorophyll content of the second leaf in soya bean, var. *illini*. Chlorophyll content at the moment of the transfer, 100

series 2 corresponds to a drastic augmentation both of the number and weight of the nodules; while an arrested accumulation of pigment in series 3 corresponds to an arrested formation of nodules.

It may be concluded that the action of day-length on chlorophyll content is related in some way to its action on the formation of root nodules.

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Xylose as a Specific Inhibitor of Photosynthesis

The energy requirements of certain green algae can be met by photosynthesis when they are supplied with carbon dioxide in light, or by chemosynthesis, using organic substrates, in light or darkness. Bristol Roach[1], Neish[2], Taylor[3] and Samejima and Myers[4] have found considerable differences in the ability of various species of algae to utilize carbohydrates as energy sources, but all have found xylose to be among those which cannot be metabolized.

In work planned to standardize the growth of *Chlorella pyrenoidosa* for herbicide tests, the organism was grown at 27–30° C. under sterile conditions in flasks around filament lamps. With minor modifications, the mineral medium was that used by Pearsall and Loose[5]. As applicable, sugar solutions were added, or carbon dioxide/air mixture was bubbled in. Preliminary tests showed that D-xylose could not be used as a substrate for chemosynthesis, but differed from all the other sugars which were tested, including D-ribose, in arresting cell division when present at

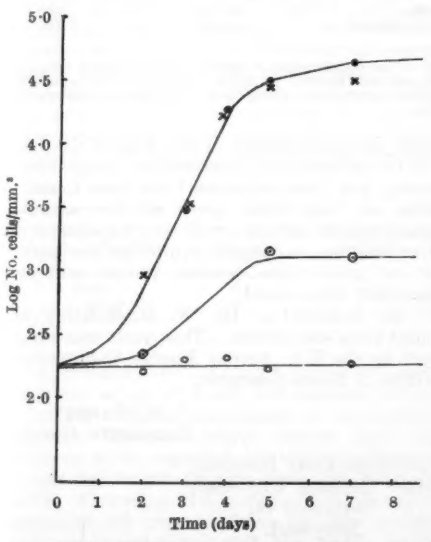

Fig. 1. Growth of *Chlorella pyrenoidosa* on glucose, and the effect of D-xylose. (Light, 470 ft.-candles.) ●——●, 0·5 per cent and 1·0 per cent glucose in light; ⊙——⊙, 1·0 per cent glucose in darkness; ○——○, 0·5 per cent xylose in light; ×——×, 0·5 per cent glucose + 0·5 per cent xylose in light

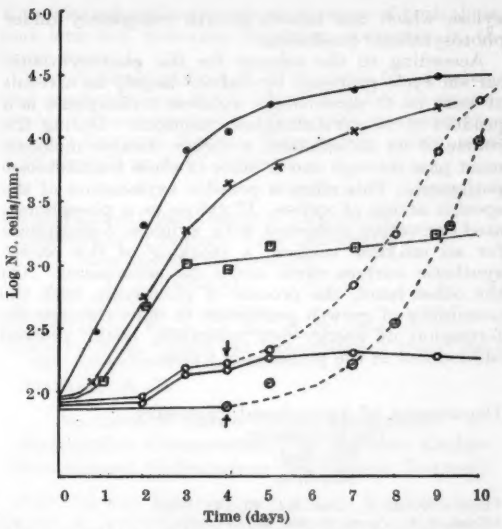

Fig. 2. Effect of D-xylose on photosynthesis of *C. pyrenoidosa*, and its reversal by addition of glucose. (Light, 470 ft.-candles; 5 per cent carbon dioxide in air.) ●——●, Control, no xylose; ×——×, 0·033 per cent xylose; ⊡——⊡, 0·1 per cent xylose; ○——○, 0·5 per cent xylose; ⊙——⊙, 1·5 per cent xylose; †- - - -, 0·5 per cent glucose also present

0·5 per cent in flasks where the algae were assimilating carbon dioxide.

Cell division was not affected by 0·5 per cent xylose when glucose, fructose or mannose was also present (Fig. 1). When glucose was the energy source, 1·5 per cent xylose in a total carbohydrate content of 2·0 per cent did not retard growth compared with that in 2 per cent glucose, even when carbon dioxide was also supplied. Thus xylose is not toxic so long as a chemosynthetic energy source is available. Neish[2] has shown that the osmotic limit for optimum utilization of glucose is 1–2 per cent, so the only factor limiting the dose of xylose which can be tolerated by *C. pyrenoidosa* when it is not living photosynthetically is the total concentration of carbohydrate.

By contrast, under photosynthetic conditions (Fig. 2), the number of cells present at the end of the exponential period at a xylose concentration of 0·033 per cent is less than one-third that in the control. Cells in flasks containing 0·5 per cent and 1·5 per cent xylose lost their colour within a few days, although some initial cell division sometimes occurred in the former. However, when 0·5 per cent glucose was added on the fourth day, the cells recovered their green colour and ability to multiply within 48 hr. This suggests that the xylose may cause the death of the cells by starvation if present under photosynthetic conditions for a sufficiently long time, but causes no permanent injury to cells which survive until an alternative energy source is provided.

C. pyrenoidosa can grow in darkness on glucose, but the growth-rate is much lower than on the same medium in light. Moreover, for the strain employed in this study, the cells were larger, darker and more granular when grown in the dark. The effect of light is frequently attributed to photosynthesis supplementing chemosynthesis. Fig. 1 shows, however, that the effect of light is not photosynthetic, for the better growth in light is fully maintained in the presence of concentrations of

xylose which can inhibit growth completely under photosynthetic conditions.

According to the scheme for the photosynthetic carbon cycle proposed by Calvin[6] largely as a result of work on *C. pyrenoidosa*, xylulose 5-phosphate is a product of two transketolase reactions. During the course of its assimilation, a carbon dioxide molecule must pass through one or other of these transketolase pathways. This offers a possible explanation of the specific action of xylose. If xylose or a phosphorylated derivative competed with xylulose 5-phosphate for an enzymic surface, a blocking of the photosynthetic carbon cycle could be anticipated. On the other hand, the process of photolysis, with the possibility of growth promotion in light through the formation of energy-rich materials, could proceed unhindered in the presence of xylose.

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Biosynthesis of Gramicidin-*S*

A fundamental problem of biochemistry is the mechanism by which the sequence of amino-acids in peptides and proteins is determined. We are studying the formation by *Bacillus brevis* of gramicidin-*S*—a cyclic decapeptide in which the sequence valyl–ornithyl-leucyl–D-phenylalanyl–prolyl occurs twice[1].

When a culture of *Bacillus brevis* (A.T.C.C. No. 9999) was aerated at 37° C. in a medium supplemented with the five amino-acids of gramicidin-*S*, a normal bacterial growth-curve was obtained. Biological assay with *Streptococcus* sp. (A.T.C.C. No. 9854) of alcoholic extracts of the bacteria showed that antibiotic activity appeared rapidly towards the end of growth and was finally equivalent to 50–100 mgm. of gramicidin-*S* per litre of culture. These alcoholic extracts, when subjected to paper chromatography with butanol–acetic acid, gave a spot with the same R_F value as an authentic sample of gramicidin-*S*, and which on hydrolysis gave the expected five amino-acids in equimolar amounts.

For studying the formation of gramicidin-*S* the cells were always harvested when the culture had reached one of three optical densities, and these cells can be called early, middle and late. The cells were washed and resuspended in solutions the compositions of which are given in Table 1; on incubation overnight at 37° C. these cells did not divide, but formed gramicidin-*S* in amounts similar to those of the experiment shown in Table 1. It is seen that in the complete medium all the cells formed gramicidin-*S*; when the medium lacked D-phenylalanine, or all five amino-acids, the formation of gramicidin-*S* by early cells was prevented, but that by late cells was unaffected. Paper chromatography showed that extracts of late cells did not contain a significant pool of free amino-acids. If the medium lacked any one of the amino-acids other than D-phenylalanine, gramicidin-*S* formation by early cells was reduced to about one-half. If suspensions of early or middle cells were disintegrated for 2½ min. in a sonic disintegrator they formed no gramicidin-*S* on incubation, but suspensions of late cells formed about half as much as usual.

Table 1. Gramicidin-*S* formed (mgm./100 ml. of suspension) by Resting Suspensions of *Bacillus brevis*

Medium	Bacteria		
	Early	Middle	Late
Complete	18	14	8·4
,, less D-phenylalanine	1·7	7·1	8·5
,, less all amino-acids	1·8	3·9	8·2

The cells were harvested at three stages of growth and each batch was washed and incubated for 16 hr. in a complete medium or one lacking certain amino-acids. The complete medium contained glucose (1 gm.), *tris* (0·66 gm.), L-valine, L-ornithine, L-leucine, D-phenylalanine and L-proline (66 mgm. each), minerals and growth factors in 100 ml. of water at *p*H 7·25.

These results suggest that when the five amino-acids are incorporated into gramicidin-*S* they pass through a number of intermediate compounds, and that the final production of gramicidin-*S* is a simple reaction which does not require free amino-acids, and which readily occurs in cell-free suspension. That intermediate compounds are stored in the cells is also suggested by experiments in which carbon-14-DL-phenylalanine and carbon-14-L-valine were added to the solution in which the washed cells were resuspended. As shown in Table 2, the specific activities of the phenylalanine and valine in the newly formed gramicidin-*S* were less than one-third of those in the solution. Paper chromatography proved that this was not due to the bacteria containing a pool of unlabelled phenylalanine and valine.

Table 2. Specific Activities of Amino-acids of Newly Formed Gramicidin-*S*

Amino-acid	Specific activity (counts/min./mgm.)	
	Medium	Gramicidin-*S*
Valine	23,700	7,130
Phenylalanine	15,300	3,200

Cells at the middle stage of growth were harvested and incubated in the complete medium of Table 1 but with the D-phenylalanine replaced by carbon-14-DL-phenylalanine and the L-valine by carbon-14-L-valine.

Paper chromatography of extracts of the bacteria has so far revealed no intermediate compounds with certainty, but three peptides have been found. One peptide, on hydrolysis, gives all the amino-acids of gramicidin-*S* except ornithine, together with an unidentified one, in roughly equimolar amounts. The other two give valine, leucine, proline and another unidentified amino-acid.

We are indebted to Dr. W. D. McElroy for his constant help and advice. This work was supported in part by the U.S. Atomic Energy Commission and the Office of Naval Research.

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Photoperiodic Control of Flowering in *Lemna perpusilla*

THE factors controlling flowering in the Lemnaceae are largely unknown. Kandeler[1] showed that certain strains of *Lemna gibba* would flower under long days, and that 'stale' media appeared to hasten flowering under such conditions. Landolt[2] reported that a strain of *Lemna perpusilla* (designated by him as 6746) flowered in old, crowded cultures under all day-lengths tested. I have recently confirmed Landolt's observations, but with the significant addition that, even in fresh medium, strain 6746 flowers rapidly under short days, and appears to respond as a typical short-day plant. These experiments, like those cited, were done under aseptic conditions.

A typical experiment showing the effects of day-length was done with cultures grown in 250-ml. Erlenmeyer flasks each containing 150 ml. of Hutner's[3] medium, *p*H 6·5, with 1 per cent sucrose. Each flask was inoculated with one 3-frond 'colony' of 6746 taken from week-old stock cultures grown under continuous light. All experimental cultures were then grown at 23–26° C. under 550–600 ft.-candles of white fluorescent light. The results are shown in Table 1.

Table 1

Photoperiod	No. of cultures	No. of cultures flowering on day 8	9	14	20
8 hr.	4	0	4	4	4
16 hr.	4	0	0	0	0

The flower-promoting effects of short days (long nights) are abolished by red-light interruptions of the dark period, as shown by the following experiment. Cultures were started as before, but using 50-ml. flasks containing 25 ml. of medium. For four successive 24-hr. cycles, all experimental cultures received 10 hr. of white fluorescent light (150–200 ft.-candles) and 14 hr. of darkness, at 26–27° C. Red-light interruptions, if any, were given in each cycle after 7 hr. of darkness had elapsed, with a red fluorescent tube as the light-source. On the fifth day all cultures were placed under the 16-hr. photoperiod conditions used previously, and observed until flowering occurred. The results are in Table 2. Cultures not flowering were dissected on day 9 and no flower primordia[1] were found, although they are easily detected after 6 days under short-day conditions.

Table 2

Red-light interruptions (min.)	(k.ergs/cm.²)	No. of cultures	No. of cultures flowering on day 8	9
None	None	4	0	4
1	about 15	4	0	0
10	about 150	4	0	0

Over a period of several months, I have been unable to detect any stage of flower development in vigorously growing cultures maintained on fresh medium by frequent transfer, except under short days. Experiments to be reported elsewhere indicate that the critical day-length for this strain lies between 13 and 15 hr. Flowering in *L. perpusilla* 6746 may thus be controlled by two at least initially unrelated factors: photoperiodism and the 'stale' medium effect. This should prove valuable for further work on the basic mechanisms controlling flowering. It is also interesting to note that this plant together with Kandeler's *L. gibba* provide an instance of both short- and long-day flowering responses occurring in the same genus.

I am indebted to Prof. A. W. Galston for his advice and encouragement and to Dr. E. Landolt for sending me his Lemnaceae strains. This work was supported by the National Science Foundation under grant *NSF G*–4433 to A. W. Galston.

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Nature of Some Decay-retardant Extractive Components in Incense Cedar Heartwood (*Libocedrus decurrens* Torrey)

THE marked durability of certain heartwoods in service is attributed to the presence of extractive components which are inhibitory to wood-destroying fungi. Among some of the more durable heartwoods are those of such native species as bald cypress (*Taxodium distichum* (L.) Rich.), redwood (*Sequoia sempervirens*)[1], western red cedar (*Thuja plicata* Donn)[2,3], osage-orange (*Maclura pomifera* (Raf.) Schneid.)[4], and black locust (*Robinia pseudoacacia* L.). There is an excellent review of the types of chemical components in heartwood which may exhibit fungicidal action by Erdtman[5].

During the past few years, the University of California Forest Products Laboratory has been investigating the extractive components present in incense cedar heartwood (*Libocedrus decurrens* Torr.)[6,7]. The heartwood of this species is prized for fence posts, rails and other uses requiring resistance to decay. This reputation for durability has not hitherto occasioned any chemical investigations as to the nature of its heartwood extractive components. In the present investigation, the decay-retarding properties with respect to various wood-destroying fungi were determined, in co-operation with the U.S. Forest Products Laboratory, for the purified compounds isolated thus far from the heartwood.

Six compounds were isolated and identified among the products present in the steam-volatile oil from incense cedar heartwood. These compounds included the following (figures represent percentage present on dry wood bases): (1), λ-thujaplicin (0·07); (2), carvacrol (0·77); (3), *p*-methoxythymol (1·00); (4), *p*-methoxycarvacrol (0·04); (5), hydrothymoquinone (0·02); and (6), thymoquinone (0·10). A cryptophenolic compound, libocedrol (1·00), was identified among the non-volatile extractive components.

The decay-retarding characteristics of each of these compounds were determined, except for minor deviations, by the standard soil-block bioassay procedure (Tentative Method of Testing Wood Preservatives by Laboratory Soil-Block Cultures. A.S.T.M. Designation: *D*1413–56*T*, 1956), which involves appraisal of the resistance of blocks containing various quantities of chemical to decay by pure cultures of selected wood-destroying fungi. The testing was done in wood rather than in an artificial medium in order to bring into the result any action of a compound detrimental to wood-decomposing

Table 1. Decay-retardant Bioassay in Order of Decreasing Effectiveness*

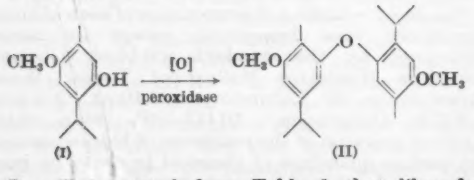
Polyporus versicolor	*Poria monticola*	*Lentinus lepideus*	*Lenzites traebea*
λ-Thujaplicin, 0	*p*-Methoxythymol, 20	λ-Thujaplicin, 1	λ-Thujaplicin, 0
Hydrothymoquinone, 0	*p*-Methoxycarvacrol, 32	Hydrothymoquinone, 7	*p*-Methoxythymol, 6
Carvacrol, 4	Hydrothymoquinone, 33	*p*-Methoxythymol, 15	Hydrothymoquinone, 13
Thymoquinone, 4	Carvacrol, 34	*p*-Methoxycarvacrol, 16	*p*-Methoxycarvacrol, 17
p-Methoxycarvacrol, 7	Thymoquinone, 42	Carvacrol, 20	Libocedrol, 17
p-Methoxythymol, 7	λ-Thujaplicin, 43	Thymoquinone, 26	Carvacrol, 18
Libocedrol, 8	Libocedrol, 46	Libocedrol, 27	Thymoquinone, 19
Control, 6–12	Control, 45–47	Control, 27–32	Control, 17–25

* Figures represent the average weight-loss in per cent caused by decay of test blocks containing 1·2 per cent, by weight, of the chemical. Test duration was six weeks.

enzymes, besides whatever direct toxic effect it might have on the test fungus. The test blocks were ponderosa pine sapwood, which were impregnated with each of the aforementioned compounds. The compounds were introduced in a solvent mixture of alcohol and water. This allowed the chemical to get into the cell walls as well as the cell cavities, a situation considered necessary in order reasonably to represent the natural one. The wood-destroying fungi used for the bioassaying were: (1), *Polyporus versicolor*; (2), *Poria monticola*; (3), *Lentinus lepideus*; and (4), *Lenzites traebea*. The results are summarized in Table 1.

These results indicate that four of the seven chemicals tested retarded in varying degrees decay by *Polyporus versicolor*, while the remaining compounds appear to have very little effect. The most potent ones, in this instance, appear to be λ-thujaplicin and hydrothymoquinone. In the case of *Poria monticola*, again four compounds retarded decay, *p*-methoxythymol being the most effective. Five compounds exhibited decay-retarding action against decay by *Lentinus lepideus*, λ-thujaplicin being the most potent. Only three compounds, namely, λ-thujaplicin, *p*-methoxythymol, and hydrothymoquinone appeared to have any decay-inhibiting action toward *Lenzites traebea*. It is likely that *p*-methoxythymol is the most influential single compound here because of its retarding effect against three of the four fungi, coupled with a relatively high content (1·0 per cent dry wood basis) in the incense cedar heartwood examined.

The cryptophenolic compound, libocedrol, is of interest from the taxonomic and biochemical point of view. It is well known that dehydrogenation of phenols by oxidases frequently causes the formation of coupled products, such as phenol ethers[8]. Thus it would appear that libocedrol (II) may be formed, *in situ*, by the enzymatic coupling of two molecules of *p*-methoxythymol (I).



(I) (II)

It will be noted from Table 1 that libocedrol exhibited very little, if any, control of decay. This finding may have some significance. As previously noted, *p*-methoxythymol was found to be among the more potent of the chemicals tested, while its dimer was not effective. The phenomenon of decreasing decay resistance with ageing of the wood in the tree occurs in many species, so there necessarily would be a variety of chemical changes involved. The present finding for *p*-methoxythymol versus libocedrol represents one type of chemical change that conceivably could account for such reduced decay resistance.

Further investigations are in progress, and it is hoped to publish full details elsewhere.

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Effects of Gibberellic Acid on Species of *Eucalyptus*

Marth, Audia and Mitchell[1] recently reported that increases in stem length of a number of woody perennials followed application of gibberellic acid. No detailed quantitative data dealing with the effects of gibberellic acid upon woody perennials has, however, appeared.

Treatments were applied to seedlings growing in pots (12 plants per treatment). The tip of the second or third leaf was cut off, the stump inserted in a tube containing 0·1 ml. of an aqueous solution of gibberellic acid and the tube then plugged with cotton-wool to reduce evaporation. Plants were treated twice, controls receiving an equivalent amount of distilled water.

The following species of *Eucalyptus* responded to treatment with gibberellic acid by producing taller, weaker stems with longer internodes and more, initially paler, leaves: *E. melliodora* and *E. polyanthemos* (Section Terminales), *E. bicostata*, *E. viminalis* and *E. blakelyi* (Section Macrantherae) and *E. fastigata* and *E. dives* (Section Renantherae). The qualitative response to gibberellic acid is thus similar for a wide range of species within the genus.

The quantitative results in Table 1 refer to *E. melliodora*. The results obtained with the other species will be presented elsewhere.

Quadratic regression curves were fitted to the results and the residual variation tested against replicate variation. A good fit was obtained, though a preliminary transformation of both variables was necessary for number of leaves. The ratio (F) of the mean square for regression to the mean square for residue plus replication is given in Table 1.

It is apparent that increase in concentration of gibberellic acid applied caused an increase in stem height and diameter, number of leaves and weight of stems, but a decrease in weights of leaf and root. Total weight was not significantly affected. The

Table 1. Effects of Gibberellic Acid on *Eucalyptus melliodora*

Gibberellic acid (μgm./ml.)	Leaf weight (mgm./plant)	Weight of stems (mgm./plant)	Root weight (mgm./plant)	Total weight (mgm./plant)	Height (mm.)	Diameter (mm.)	No. of leaves on main stem
Control	344	84	202	630	122	1·64	15·0
1	272	92	187	551	158	1·83	16·5
5	279	136	170	585	249	1·83	19·4
25	210	171	140	521	320	1·97	18·2
50	223	236	133	592	396	2·12	20·0
100	232	323	142	697	471	2·19	20·6
Test of regression F (2, 21 d.f.)	3·00	21·57	3·71	1·02	18·71	12·38	11·96
Significance	$P < 0·10$	$P < 0·001$	$P < 0·05$	n.s. at $P = 0·10$	$P < 0·001$	$P < 0·001$	$P < 0·001$

overall effect of treatment appeared to be, therefore, an alteration in the relative weights of stems, leaves and roots; increase in stem weight was achieved at the expense of leaf and root weights. A reduction in axillary branch number was observed but has not as yet been confirmed. Until the results of anatomical investigations are available, it is uncertain whether the increase in stem diameter is the result of increased cambial activity or merely increased cell size. No effect of treatment on ligno-tuber formation was apparent.

Plants treated with gibberellic acid developed the alternate arrangement and falcate-lanceolate shape of leaves characteristic of adult plants of *E. melliodora* earlier than control plants. This raises the possibility that gibberellic acid or similar substance, formed within the plant, might normally be a factor controlling leaf shape. The recent use of gibberellic acid to convert adult to juvenile foliage in a species of *Hedera*, though the opposite effect to that here anticipated, is of interest in this connexion[2].

We are grateful to Mr. G. A. McIntyre for the statistical treatment of the results in Table 1.

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Rapid Determination of Casein in Milk

More than half the total acidity of milk is due to casein. This casein, which occurs in the form of calcium caseinate, can be removed by curdling the milk with rennet. The amount of calcium bound to casein is related to the acidity of the milk; the higher the acidity, the lower the calcium content of the casein. We therefore conclude that the casein content can be determined on the basis of milk acidity and of acidity of whey obtained by rapid precipitation of the calcium caseinate with rennet; it will be proportional to the difference between total milk acidity and acidity of whey. Moreover, for a given milk in which the casein content does not change, this difference will be higher, the higher the milk acidity at the moment of adding rennet. Hence the coefficient used for multiplying the difference between milk and whey acidity for determining the casein content must be lower the higher the acidity of the milk under investigation. This determination should not be affected by the development of microflora in the milk (as is the case with the formol method), since amino- and carboxyl-groups are liberated equally.

On the basis of these theoretical considerations, the following method was developed:

(1) The acidity of the milk under investigation is determined in Soxhlet–Henkel degrees. This is the titre of $N/4$ sodium hydroxide with 100 ml. of milk, using 2 ml. of a 2 per cent alcoholic solution of phenolphthalein as indicator.

(2) 10 ml. of a 1 per cent aqueous solution of rennet is added to 90 ml. of the milk under study. The mixture is then heated on a water bath, first at 40° C., later at around 60° C. in order to accelerate the curdling and separation of whey. The whole operation, including the separation of a sufficient amount of whey, should not take longer than 5 min.

(3) The acidity of the whey obtained is determined in Soxhlet–Henkel degrees. The casein content is calculated from the equation $x = (a - 1·11b)k$, in which x is the percentage casein content of milk, a is the milk acidity and b the whey acidity in Soxhlet–Henkel degrees, k is the ratio: casein percentage/milk acidity minus whey acidity, and the coefficient resulting from the dilution of milk with the rennet solution is 1·11.

A number of such determinations on milk from the Warsaw Voivodship was carried out at this Institute, together with simultaneous determinations by the Kjeldahl method. k was calculated in each determination for various milk acidities. It was found to depend on milk acidity and can be represented as a straight line having the following equation:

$$k = 1·2863 - 0·0618\,a$$

where a is the milk acidity in Soxhlet–Henkel degrees (within the range 6·5–10·0 degrees).

Hence $x = (a - 1·11b)(1·286 - 0·062a)$.

The mean deviation of results for casein content obtained by this method from those obtained by the Kjeldahl method was 0·051 per cent; the maximum being 0·115 per cent.

We also investigated the effect of the initiation of protein hydrolysis on our results. Determinations were simultaneously carried out using the Kjeldahl, formol and our methods, before, and several hours after, the introduction of proteolytic bacteria into the milk. The formol method showed an increase of 0·222 per cent in the casein content, whereas with our method the differences from the Kjeldahl method were only 0·007 per cent, and 0·020 per cent. Hence we conclude that slight protein hydrolysis has no decisive influence on the results obtained by our method.

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Effect of Insulin on Sodium in Muscle

When diaphragm muscle is suspended in oxygenated Krebs solution at 38° C., it remains viable for many hours. Analysis, however, has shown that prolonged immersion of the muscle in physiological saline is associated with a small loss of potassium from the tissue and a considerable increase in sodium[1]. Preliminary experiments suggested that this increase in tissue sodium could be largely avoided if the muscle was suspended in rat serum instead of in saline. Later, reconstituted human freeze-dried serum was found to be as effective as rat serum, and has been used in the experiments reported here.

Diaphragm muscle was quickly removed from decapiteted male rats weighing 110–120 gm. and suspended for 2 hr. at 38° C. in aerated saline which was similar to that employed previously by one of us[1], except that 5 mM potassium was used. The sodium content of these muscles was measured[1] and compared with that of muscles immersed for 2 hr. in the other aerated fluids listed in column 2 of Table 1. The reconstituted human serum used in experiment 1 was dialysed before use for 18 hr. against repeated changes of saline.

Table 1. Sodium Content of Soaked Diaphragms (m.moles/kgm. Wet Tissue ± S.E.)

Exp. No	Test solution	Diaphragm soaked in: Test solution	Saline	No. of pairs	P
1	Dialysed human serum	35·1±0·6	48·6±1·6	12	<0·01
2	Saline plus serum proteins	35·4±0·8	54·3±3·4	6	<0·01
3	Saline plus insulin (0·01 unit/ml.)	42·6±1·5	53·0±1·5	9	<0·01
4	Saline plus insulin (0·01 unit/ml.) after cysteine	54·4±1·6	56·0±1·1	5	>0·2
5	Serum after cysteine	36·9±0·8	50·7±1·9	6	<0·01

The sodium content of diaphragms removed and not soaked was 32·7 m.moles/kgm. wet tissue ± 0·4 (S.E. of thirty-three measurements).

Table 1 shows that muscles suspended in human serum which has been dialysed against saline (experiment 1) have a lower sodium content than control muscles soaked in saline. There was no loss of potassium from these muscles. Measurement of the extracellular space with inulin showed that the difference in sodium content shown in experiment 1 was not attributable to alterations in the extracellular sodium. Control experiments in which sucrose was used (0·05 gm./100 ml. saline) did not support the view that the action of serum was attributable to osmotic effects.

The proteins of reconstituted human serum were salted out by saturated ammonium sulphate, redissolved and dialysed against saline, the final volume being adjusted to that of the original serum. Table 1 (experiment 2) shows that the presence of the proteins (or of other substances precipitated by ammonium sulphate) preserved the low sodium content of soaked muscles, as did serum. Extraction[2] of the serum with lipid solvents (ethanol/ether 3 : 1 or chloroform/methanol 2 : 1) did not significantly alter the ability of the serum to maintain a low sodium content in soaked muscles.

Saline containing insulin (0·01 unit/ml.) was effective in maintaining a low sodium content (experiment 3), and it prevented loss of potassium. The insulin/saline was also treated anaerobically at 18° C. with cysteine/hydrochloric acid (20 mgm./ml.) for 12 hr., and the cysteine was later removed by dialysis against saline. After such treatment the insulin failed to maintain muscle sodium at a low value (experiment 4), which is in accord with the observation[3,4] that insulin is inactivated by cysteine. It was therefore of interest to try the effect of cysteine on serum. Experiment 5 shows that serum after treatment with cysteine (and dialysis) was still able to maintain a low sodium content of test muscles.

The ability of plasma to maintain muscle sodium at a low value has been found in the case of the frog[5]. Experiments with radioactive sodium have indicated that the presence of insulin and glucose in saline gives a lower sodium content of test muscles as compared with controls in which these are both absent[6]. The effect of insulin in maintaining low sodium in muscle is consistent with the higher potassium and raised membrane potential of rat muscle soaked in insulin/saline[7]. It seems that proteins or other substances, in concentrations found in serum, can maintain a low sodium content of soaked muscles even with the insulin inactivated. It is therefore not certain whether insulin is a physiological factor which is responsible for the low sodium content of diaphragm muscles *in vivo*.

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Hypothalamus and Oxytocin

Evidence has recently been produced that, in the rat, oxytocin is synthesized in the paraventricular nucleus[1]. After small electrolytic lesions in this region a decrease in the amount of oxytocin was found in the posterior pituitary with no change in its vasopressin content. Robertson and Hawker[2] have demonstrated the presence of a second oxytocic substance in the hypothalami of cows, oxen, cats (and kittens), rats and mice, but this substance was not present in pituitary extracts. This oxytocic substance differs from naturally occurring oxytocin in its stability towards 0·01 M thioglycollate; this procedure inactivates the hormones of the posterior pituitary[3].

There is some evidence that the second oxytocic substance recovered from blood extracts by Hawker and Robertson[4] and Hawker and Roberts[5] may be synthesized in the paraventricular nucleus of the hypothalamus together with oxytocin. First, the correlation of percentages of second oxytocic substance with the total oxytocic activity in extracts of

Table 1. Oxytocic Activity of Extracts of Blood and Hypothalamus in Rats

Blood				Hypothalamus			
Total oxytocic activity	Oxytocin (m.u./ml. blood)	Second oxytocic substance	Second oxytocic substance/total oxytocic activity (per cent)	Total oxytocic activity	Oxytocin (m.u./hypothalamus)	Second oxytocic substance	Second oxytocic substance/total oxytocic activity (per cent)
1·8	0·34	1·46	81	8·28	0	10·1	> 100
1·75	1·00	0·75	43	7·66	5·38	2·28	30
2·38	0·65	1·73	72	10·42	3·26	7·16	70

blood and hypothalamus of the male rat are shown in Table 1. In each case, extracts of hypothalami and blood were made from the same rat and assayed in parallel on the sensitized virgin rat uterus.

Secondly, blood extracts prepared from male rats with bilateral electrolytic lesions in the region of the paraventricular nuclei (using the Horsley–Clark stereotaxic instrument) possessed less oxytocic activity than similar extracts both from the control group and from those with lesions in the posterior hypothalamus. Table 2 shows that most of the oxytocic activity in these male rat blood extracts is due to second oxytocic substance, and since in the last group the total oxytocic activity in each case is less than the amount of second oxytocic substance in the first two groups, it suggests a decrease in the level of that substance in the blood as a consequence of the lesions in the paraventricular nuclear area.

Table 2. Oxytocic Activity of Blood Extracts after Lesions in Hypothalamus

Position of lesions		Blood extracts			
		Total oxytocic activity	Oxytocin (m.u./ml. blood)	Second oxytocic substance	Second oxytocic substance/total oxytocic activity (per cent)
None	(1)	1·33	0·28	1·05	79
	(2)	1·8	0·34	1·46	81
	(3)	3·3	1·2	2·1	60
	(4)	2·46	0·31	2·15	88
Post-hypothalamus	(5)	2·1	0·72	1·28	61
	(6)	1·46	0·19	1·27	87
	(7)	2·15	0·03	2·11	98
	(8)	1·09	0·30	0·79	75
Near paraventricular nucleus	(9)	⩽0·44		*	*
	(10)	0·50			
	(11)	< 0·28			
	(12)	0·77			

* Insufficient extract left for assay of second oxytocic substance.

Thus it appears that the second oxytocic substance is closely related to oxytocin in its release from the paraventricular nucleus. This would explain its reduction following paraventricular lesions, and also the correlation between the level of second oxytocic substance in blood and hypothalamic extracts. Further experiments are being carried out along these lines to confirm these preliminary results.

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Absence of Abnormal Hæmoglobins in Some Groups of the Papua Population of Dutch New Guinea

As results of various surveys on the occurrence of hæmoglobinopathies in different countries become available it appears that the number of carriers of one of these hereditary aberrations is relatively high among the populations of many countries: Central and North Africa, Italy, Greece, the Middle Eastern countries, Iran, India, Pakistan, Ceylon, Burma, Thailand and Indonesia. In many of these countries malaria is common. There are positive indications that the presence of hæmoglobins *S* and *F* lowers the mortality-rate of young children infected with malaria. For the other abnormal hæmoglobins such a relation has not yet been established. Lie Injo Luan Eng[1] found among the Sudanese and Javanese populations of Java respectively that 2·5 and 4·5 per cent were carriers of hæmoglobin *E*. Lehmann *et al.*[2] found 13·1 and 5 per cent respectively in the Malaysian Malays of two districts. In the Dyaks of Sarawak the number of hæmoglobin *E* carriers was found to be very low[3]. Farther east, in the Celebes, the percentage of carriers of hæmoglobin *E* was found to be low (1 per cent). Lie Injo Luan Eng[1] and Lehmann *et al.*[4] found no abnormal hæmoglobin in the Australian aborigines.

We have been able recently to study the blood of East Indonesians from Ambon and other islands in the eastern part of the archipelago who have come to Holland (135 samples) together with the blood of Papuans collected by one of us in Dutch New Guinea (250 samples). Both paper electrophoresis and column chromatography were carried out on each specimen. No abnormal hæmoglobin was encountered, nor any increased amount of fœtal hæmoglobin. It is noteworthy that in many parts of New Guinea malaria is holo-endemic. In the holo-endemic malaria districts of Central Africa, the spleen index among the adult population is far lower than that found in New Guinea. The question arises whether there is a relation between the high spleen index in the adult Papuan and the absence of abnormal hæmoglobins in this population.

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An Olfactory Response of Immature Adults of the Desert Locust

Norris has shown[1] that a stimulus, probably chemical, produced by mature, yellow males of *Schistocerca gregaria* (Forsk.) accelerates the maturation of immature males and females. In the present work, a volatile substance, which is produced all over the body, has been detected in yellow males. It is not yet possible to say whether the stimulus demonstrated by Norris and the volatile substance are identical, but they have certain properties in common.

Extracts of this latter substance, or parts of a yellow male, held in front of the antennæ of an immature adult of either sex release a special reaction. The antennæ begin to move in a non-directional manner, and this is followed by strong agitation of the two pairs of palpi. Then the hind femora begin to vibrate rapidly, the lateral component of the movement being relatively larger than the antero-posterior movement. The amplitude and duration seem to vary with the state of excitement, which depends upon the quantity and possibly the quality of the releasing stimulus. The hind femora while in motion do not touch the elytra, and tests with sonic and ultrasonic microphones have shown that the vibration reaction contains no acoustical component.

Amputation and masking experiments suggest that the olfactory receptors concerned are in the antennæ. The palpi have been found to be unimportant for the reception of the stimulus.

The substance is soluble in oil and remains active in mature males for 3–4 days after death. Only yellow, fully mature males produce sufficient of it to release the vibration reaction. Young adults show the olfactory response 4–8 days after emergence and continue to do so until they are fully mature. The reaction can also be released independently of olfactory stimulation by tactile, visual or acoustical stimuli. Further work on this chemical stimulus is in progress, and a detailed account will be published elsewhere.

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Facilitated Diffusion and Exchange in the Absorption of Glucose by the Locust, *Schistocerca gregaria* (Forsk.)

Glucose absorption in the locust, *Schistocerca gregaria* (Forsk.), is largely confined to the mid-gut region of the alimentary canal, the uptake proceeding most rapidly from the mid-gut cæca[1]. The rate of disappearance of glucose labelled with carbon-14 from the lumen of the mid-gut was found to be related to its rate of conversion to a disaccharide, trehalose, which accumulated in the hæmolymph. When the isolated alimentary canal was suspended in a relatively large volume of circulating poisoned saline, the disappearance of glucose was similar to that in the intact animal. On the basis of these observations it was suggested that the absorption of glucose might be achieved by diffusion across the gut wall, this process being facilitated by the rapid conversion to trehalose, which would tend to maintain a steep concentration gradient across the gut wall[1]. This can be described as facilitated diffusion, in the sense that this term is used by Danielli[2].

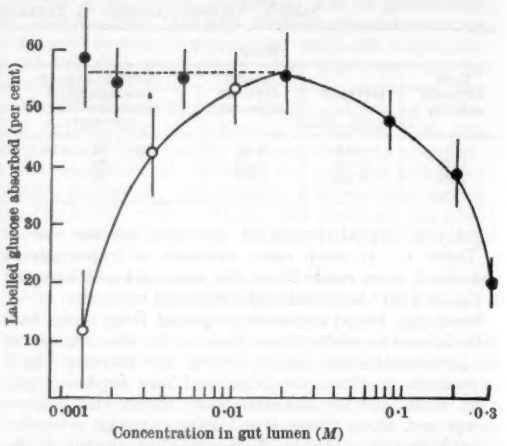

Fig. 1. The effect of concentration on the movements of glucose labelled with carbon-14 between the mid-gut cæca and the hæmolymph during an experimental period of 15·0 min. The open circles represent the percentage absorption of labelled glucose when the initial radioactivity of the glucose in the hæmolymph, in equilibrium with trehalose, approximated to that in the gut lumen; the closed circles represent the uptake when there was no initial radioactivity in the hæmolymph. The vertical lines indicate the extent of the standard deviation

It is known that there is a small amount of glucose in equilibrium with the trehalose in the hæmolymph of this insect[3]. In the present investigation the concentrations were found to be $24{\cdot}1 \pm 12{\cdot}9$ mgm./100 ml. glucose and $694{\cdot}5 \pm 99{\cdot}3$ mgm./100 ml. trehalose. Thus when the glucose in the gut lumen is low, the concentration would be similar to that in the hæmolymph. To investigate the movements of glucose between the gut and the hæmolymph at low concentrations the uptake of labelled glucose

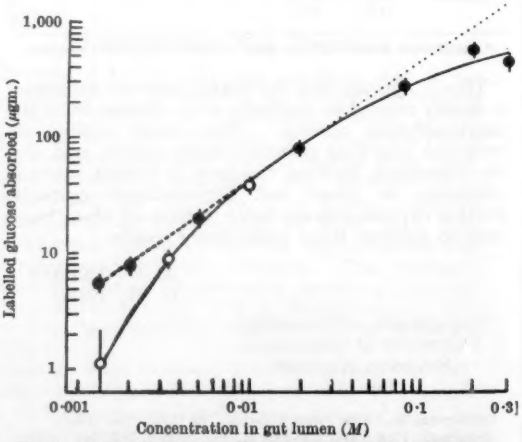

Fig. 2. A logarithmic plot illustrating the uptake of labelled glucose from the mid-gut cæca, in absolute units, calculated from the results illustrated in Fig. 1. The continuous line represents the net glucose absorption, while the broken one includes an estimate of the uptake of labelled glucose resulting from an exchange with that in the hæmolymph

was studied under conditions in which the specific activity of labelled glucose in the hæmolymph, where it is in equilibrium with trehalose, approximated to that in the gut lumen. This was achieved by injecting sufficient labelled glucose into the hæmolymph so that, when it had come into equilibrium with the trehalose, the radioactivity of the glucose was similar to that in the gut lumen. Results obtained under these conditions have been compared with those for the uptake of labelled glucose by insects initially containing no radioactive material in the hæmolymph.

It has been found that the presence of labelled glucose in the hæmolymph greatly reduced the percentage absorption of the labelled glucose from the gut lumen when the concentration there was low. This effect decreased with increasing concentration and became negligibly small when a concentration of about 0·01 *M* was reached in the lumen. These results are summarized in Fig. 1. The absolute amount of labelled glucose (in μgm.) absorbed from the lumen of the cæca can be calculated from the results in Fig. 1, from the fact that the initial volume of the cæca contents averaged 0·039 ± 0·009 ml. (Fig. 2). The net glucose absorption from the mid-gut cæca is thus represented by the continuous line in Fig. 2. Thus at relatively low concentrations much of the uptake of the labelled glucose molecules was due to exchange with that in the hæmolymph. With increasing concentration the proportion exchanging with that in the hæmolymph became progressively smaller.

It is clear, therefore, that the postulated facilitated diffusion mechanism, involving the conversion to trehalose, can only produce a net glucose absorption when the concentration in the gut lumen exceeds the very low level in the hæmolymph. At very low concentrations some additional mechanism must be postulated to explain any net glucose absorption which may be observed. This topic will be considered more fully in a detailed account of this work to be published elsewhere.

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Role of Glycerol in producing Abnormally Low Supercooling and Freezing Points in an Insect, *Bracon cephi* (Gahan)

Most insects have freezing points only a degree or two below 0° C., but can be supercooled to much lower temperatures[1]. When supercooling points as low as −47° C. were recorded[2] for overwintering larvæ of *Bracon cephi* (Gahan), a parasite of the wheat stem sawfly, *Cephus cinctus* Nort., abnormally low freezing points were expected because water is highly unlikely to supercool[3] more than 40 deg. C. Freezing points (determined as melting points[1]) of the hæmolymph of these larvæ ranged from −7° to −17° C. These values were closely related to the corresponding supercooling points of the intact insects, which were 28–30 deg. C. lower. This uniform amount of supercooling conforms with Lusena's findings[4] with aqueous solutions of sodium chloride and glycerol.

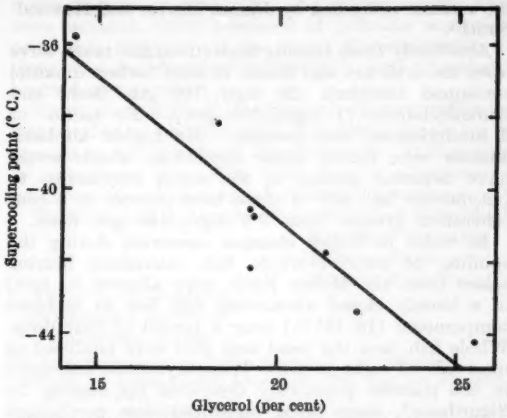

Fig. 1. Relation of glycerol contents of larvæ of *Bracon cephi* (Gahan) to their supercooling points. Regression line calculated

In an attempt to account for the very low freezing points found in *B. cephi* larvæ, the amounts of glycerol were estimated by a chromatographic method[5] in samples of ten larvæ each. Three chromatograms were run for each sample and two estimates based on different concentrations and glycerol standards were obtained from each chromatogram. The mean glycerol content of eight samples was 20·0 per cent, calculated as percentage of glycerol plus water content. Alone, such a solution would freeze at −4·8° C. The excess depression observed in insects is partly due to and may be fully accounted for by salts, sugars, amino-acids and neutral solutes other than glycerol. However, Fig. 1 shows a supercooling-point depression (and consequently an approximately equal freezing- or melting-point depression) of 7·9 deg. C. for a 10 per cent increase in glycerol (from 15 to 25 per cent). In corresponding pure glycerol solutions the depression for this range is 4·1 deg. C. The difference can be accounted for by glycerol if it binds a considerable portion of the insect's water content, thereby concentrating other solutes. The alternative is a high titre of other freezing-point depressants.

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Volatile Amines of Herring Flesh

Gas chromatography[1,2] affords a rapid method for the specific identification and estimation of the volatile amines which are produced in fish flesh. In the experiments to be described, amines were quantitatively extracted from the flesh of herring (*Clupea harengus*) with aqueous 10 per cent trichloracetic acid solution and steam distilled at *p*H 10 into excess dilute hydrochloric acid solution. The distillate was concentrated under reduced pressure, and finally freeze-dried. The resulting residue of amine hydrochlorides was dissolved in a suitable volume of water and applied to the gas chromatography column in

the manner described by James, Martin and Howard-Smith[1].

Absolutely fresh herring flesh (from fish taken alive from the drift net and frozen in solid carbon dioxide) contained ammonia (20 mgm./100 gm. flesh) and trimethylamine (1 mgm./100 gm.). No mono- or di-methylamine was present. No higher aliphatic amines were found under conditions which would have detected amines in the series ethylamine to butylamine had any of these been present in a concentration greater than 0·5 mgm./100 gm. flesh.

In order to follow changes occurring during the spoiling of un-iced whole fish, immature herring taken from the Moray Firth were allowed to spoil in a loosely closed aluminium fish box at ambient temperature (10–12° C.) over a period of four days. Whole fish (less the head and gut) were analysed at intervals of eight hours. Trimethylamine increased in the manner previously described for herring by Sigurdsson[2], there being an initial slow production (10 mgm./100 gm. after 40 hr.) followed by a more rapid increase, with a final levelling off after 90 hr. at about 100 mgm./100 gm. During the same period ammonia increased from 15 mgm./100 gm. to 56 mgm./100 gm. and dimethylamine from nil to 8 mgm./100 gm. A very small quantity of monomethylamine was formed, being first detected after 56 hr. and increasing to 1 mgm./100 gm. after four days. No higher volatile amines were formed during the period.

In order to investigate changes taking place when herring flesh is heat-processed (as in canning), blocks of flesh were heated in sealed glass tubes for periods of up to 5 hr. at 120° C. The cooked flesh and exuded liquor were combined for analysis, and average results are shown in Table 1.

Table 1. Amines produced on Processing Herring Flesh in Sealed Glass Tubes at 120° C.

Time of heating (hr.)	Mgm./100 gm. (raw flesh basis)		
	Ammonia	Trimethylamine	Dimethylamine
0	19·0	5·1	0·3
1	24·5	18·3	4·9
2	39·3	38·1	12·3
3	47·8	47·0	18·9
4	49·0	63·4	23·3
5	48·4	53·5	25·9

A very small quantity of monomethylamine was also formed, not detectable until after two hours heating, and reaching 1 mgm./100 gm. after five hours. No higher amines were formed.

The most remarkable feature of these results is the large amount of dimethylamine formed during cooking. Approximately 1 mole of dimethylamine is produced per 2 moles of trimethylamine. Trimethylamine oxide has long been known to be the precursor of trimethylamine in spoiling fish flesh, but the origin of dimethylamine is not so certain. Shewan[4] suggested that the precursor here was trimethylamine oxide, but later he found that certain bacterial strains, known to produce dimethylamine from fish-muscle juice, could not produce the amine from a substrate containing trimethylamine oxide. More recently, Vaisey[5] has suggested a mechanism whereby dimethylamine can be formed from trimethylamine oxide by purely chemical means. He found that in aqueous solution at 22–24° C., trimethylamine oxide is rapidly reduced by reducing agents such as cysteine, hæmoglobin and ferrous ions catalysing the reaction. Although trimethylamine is the main product, considerable quantities of dimethylamine, and some formaldehyde are also formed. Whether such reactions occur in spoiling fish flesh, perhaps catalysed by bacterial enzymes, is still uncertain. In cooking flesh, however, it is almost certain that the breakdown of trimethylamine oxide follows some such course. Thus Ronold and Jakobsen[6] found that although trimethylamine oxide was completely stable when heated in glass vessels at 107° C. for several hours, the trimethylamine oxide content of homogenized herring fillet paste dropped under similar conditions and this drop was increased by placing steel or tinplate strips in the paste. An increase in the formaldehyde content of herring during canning has been reported by Lunde and Mathiesen[7].

The source of the ammonia produced in cooking herring flesh is not known. The quantity of urea present in the flesh (2·9 mgm. nitrogen/100 gm.)[8] is too small to account for the production of ammonia (2 millimoles/100 gm.). It has been found (unpublished work) that nitrogenous substances such as creatine and histidine, which are present in herring muscle juices in considerable quantity (520 mgm. and 150 mgm./100 gm. flesh respectively), are rapidly degraded during cooking, their decomposition products not being known. These and other such reactions may well account for the production of ammonia.

This work, which it is hoped to report in greater detail elsewhere, forms part of an investigation into factors affecting the quality of canned herring.

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Presence of a Threonine-containing Phospholipid in Tunny Muscle

It has previously been observed by many workers that the phospholipid fractions from several animal tissues contain unidentified bases in addition to choline, ethanolamine, or serine. Recently, Rhodes and Lee[1] showed the existence of a small amount of threonine in the phospholipids of hen's egg. We have also found threonine in the hydrolysate of the so-called cephalin fraction, obtained from the muscle of a tunny, *Thynnus orientalis*[2]. From this fraction we prepared dinitrophenyl derivatives, from which a small amount of a phospholipid containing dinitrophenylthreonine was obtained, besides considerable quantities of lipids containing dinitrophenylserine and dinitrophenylethanolamine, by means of chromatographic separation on a silicic acid/'Celite' column. These substances have been identified by chromatographic methods, periodate oxidation, and analytical results.

5 kgm. of tunny muscle was minced, and extracted successively with acetone, ethanol and petroleum ether. From these extracts, a phospholipid fraction which was soluble in petroleum ether but insoluble in acetone and ethanol was collected. This fraction was repeatedly fractionated by Folch's procedure[3,4] to yield a phosphomonoaminolipid fraction which was free from inositol-containing lipids and mineral bases; yield 2·98 gm., phosphorus 4·08 per cent, nitrogen 1·81 per cent, iodine number 33·6. The fraction consumed no periodate. From the hydrolysate of the lipid, ethanolamine, serine and threonine were identified by paper chromatography, but no free nitrogeneous bases were detected on a chromatogram of the lipid itself. To 2·40 gm. of the lipid dissolved in 35 ml. of chloroform, 25 ml. of a 7 per cent ethanolic solution of 2,4-dinitrofluorobenzene, and 25 ml. of a 4 per cent aqueous sodium carbonate were added. After this mixture had been shaken for 20 hr. at room temperature, the chloroform layer was removed. The residual aqueous layer, after being acidified with hydrochloric acid, was extracted with 10 ml. of chloroform.

The chloroform solutions were combined and evaporated. The dinitrophenyl derivatives were dissolved in 3 ml. of chloroform, then chromatographed on a silicic acid/'Celite' (2 : 1) column (2·7 cm. × 20 cm.). From band 1, eluted with chloroform/methanol (98 : 2), dinitrophenylethanolamine was isolated and identified after hydrolysis. From band 2 eluted with chloroform/methanol (9 : 1), 1·28 gm. of a yellow derivative was obtained. Dinitrophenyl-serine and dinitrophenylthreonine were found on a paper chromatogram of the hydrolysate of this material. Then this fraction was again allowed to pass through a silicic acid/celite (2 : 1) column (1·5 cm. × 20 cm.), eluting with a mixture of chloroform and methanol (1 : 1), to yield 0·825 gm. of band 2*a* and 0·210 gm. of band 2*b*. The band 2*a* (0·810 gm.) was refluxed with 25 ml. of 6 *N* hydrochloric acid and 25 ml. of ligroin for 20 hr. After hydrolysis, the acid layer was twice extracted with 15 ml. of ligroin to remove the fatty acids, evaporated *in vacuo* to dryness and finally dried in a desiccator over sodium hydroxide. The residue was stirred with a small amount of water and the solution was extracted with ethyl acetate. The extract was chromatographed on a silicic acid/'Celite' (2 : 1) column, eluting with acetic acid/ethyl acetate/ligroin (1 : 1 : 8); 7 mgm. of dinitroaniline and 125 mgm. of dinitrophenylserine were isolated and identified. Material in band 2*b* was hydrolysed in the same manner as described above. Chromatographic separation of the dinitrophenyl-amino-acids gave 5 mgm. of dinitroaniline, 26 mgm. of dinitrophenylthreonine (m.p. 149–52° C., found, per cent: C 41·99, H 3·70, N 14·62; calculated for $C_{10}H_{11}N_3O_7$, per cent: C 42·11, H 3·88, N 14·73), and 8 mgm. of dinitrophenylserine.

Hydrolysis of these dinitrophenyl-amino-acids by the method of Lowther[5] yielded the corresponding free amino-acids. From the products of periodate oxidation of the threonine, acetaldehyde and glyoxylic acid were identified.

The ligroin solutions obtained in the hydrolysis of the band 2*b* were combined, washed, dried and evaporated. The residue was saponified with ethanolic potassium hydroxide, extracted with ethyl ether to remove unsaponifiable materials, then acidified with hydrochloric acid and extracted with ethyl ether. The ether solution was evaporated to dryness: 0·081 gm. of mixed fatty acids with a neutralization number 209·7 and iodine number 45·6 were isolated. The presence of palmitic and oleic acids was detected on the paper chromatograms of their 2,4-dinitrophenylhydrazides[6] and mercuric-acetate complexes[7].

From the results thus obtained, it may safely be stated that a phospholipid containing threonine is present in the lipid from tunny muscle. It may also be presumed that this lipid has a structure of palmitoyl-oleoyl-glyceryl-phosphoryl-threonine.

The details of this work will be published elsewhere[8].

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Effect of Photoperiodism on Response of Juvenile Trout to Water Currents

Controlled photoperiods have been used to induce a variety of physiological changes associated with pituitary and gonadal activity. Effects of photoperiodism on environmental adaptations and behavioural responses—other than reproductive—have been less frequently investigated, especially in juvenile animals. The importance of photoperiod control has been shown in the responses of stickleback to salinity[1] and in variable thermal resistance of goldfish[2]. The experiments reported here on trout (*Salmo gairdneri*) indicate that photoperiodism may be as significant in juvenile as in adult fish.

Rainbow trout fingerlings, hatched in May 1957, were acclimatized to temperature in six holding tanks during October 1957, two tanks held thermostatically at 10°, two at 15° and two at 20° C. On November 4, 1957, light hoods were placed on each tank. One set of tanks at 10°, 15° and 20° C. received 8 hr. illumination alternating with 16 hr. darkness, while three others at the same temperatures received 16 hr. illumination alternating with 8 hr. darkness. Incandescent bulbs (7·5 watts) provided illumination varying between 2·4 and 4·8 ft.-candles at the water surface during the 'day' period.

Response of trout to water current was tested in a continuous flume 50·8 cm. wide, 35·6 cm. deep and 9·7 m. in circumference measured at the middle of the channel. Fish were free to swim in either direction around the flume without interruption, and when doing so were said to 'cycle' with or against the current of water. The flume extended around the periphery of a room in which illumination by an overhead incandescent lamp varied between 0·5 ft.-candles in shade of flume wall and 7·5 ft.-candles in direct light at the water surface. At a depth of 15 cm. in the water a current with a maximum velocity of 9·7 cm./sec. (mean cross-sectional velocity of 4·2 cm./sec.) was maintained in the flume by a screened pumping system. Water temperature was controlled thermostatically. Cover and resting

positions were provided for fish by placing stones (15–25 cm. in diameter) at intervals along both sides of the flume.

Fish were removed from a holding tank, placed in the flume at their acclimatization temperature (maintained throughout the test) and left for one hour before observation. All observations were made during 'day' periods for fish tested.

Groups of five fish were used for each experiment. Reactions to current were measured by counting the number of times fish made a complete cycle around the flume, either upstream or downstream within a 5-min. period. Observations were continued at intervals until responses were recorded for from 9 to 15 separate 5-min. periods. Replications (three to five) were made with different lots of five fish at each temperature and day-length. Experiments were begun forty-one days after fish were first exposed to controlled day-length and were completed forty days later.

Fingerling trout used in experiments ranged between 55 and 125 mm. in fork length. No difference was noted in gonadal development between 8-hr. and 16-hr. fish either in gonad appearance or in the ratio of gonad to total body-weight. Gonads appeared to be characteristically immature.

The current response of young trout held at different temperatures and day-lengths is shown in Fig. 1. Fingerlings held at a 16-hr. day-length exhibited a strong negative reaction to current, particularly at low holding temperature, and only in one lot (at 15° C.) was an appreciable amount of upstream swimming observed. On the other hand, 8-hr. day-length fingerlings showed virtually no downstream cycling but moved upstream against the current, especially at the low holding temperature (10° C.). Fish at both day-lengths showed less cyclic movement, either upstream or downstream, at the high holding temperature (20° C.) and tended to maintain position in the current.

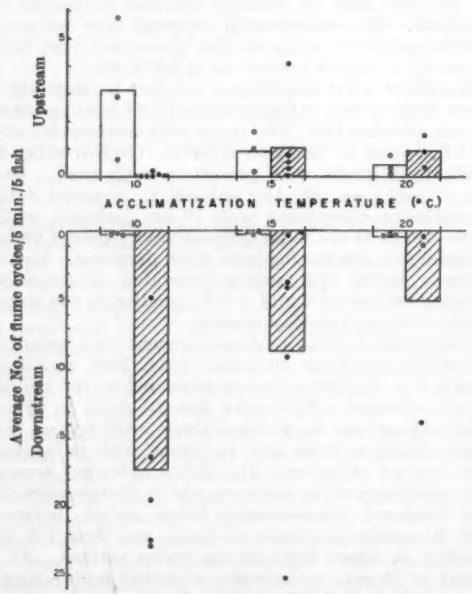

Fig. 1. Response to water current of young rainbow trout held at different temperatures and day-lengths. Average cycles for 8-hr. day-length lots: unshaded, all lots; ○, individual lots; average cycles for 16-hr. day-length lots: shaded, all lots; ●, individual lots

In their strong negative response to current, long day-length trout cycled actively, heading downstream in the current, often at a velocity higher than that in the flume. At low holding temperature, downstream swimming velocities two to three times that of maximum water velocity were recorded.

Fingerlings moving upstream or downstream occasionally swam in groups. These associations, however, were not permanent throughout the observation periods, as various individuals stopped movement periodically to hold position behind stones. Response to current appeared to be an individual reaction, although resting fish at times joined others as they moved past.

Field studies on movement of young rainbow trout in outlet and inlet streams of Loon Lake, British Columbia, have been carried on for several years. Results from these studies indicate that water current response of young trout related to day-length and temperature may be of significance in directing their movement from outlet and inlet rearing streams into lakes. However, in the field no marked downstream movement of fingerling trout has been observed in streams during periods when day-length and temperature conditions might be compared to the experiments conducted at 10° C. with 16 hr. day-lengths. Further experiments are being conducted to examine the immediate and delayed effect of change of temperature upon the reaction to current of young rainbow trout held at controlled temperatures and photoperiods.

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Interrelationships of the Concentrations of Sodium, Potassium, Lactose and Water in Milk

The constancy of the osmotic properties of milk has led to a number of attempts to relate to each other, on either a theoretical[1] or an empirical[2,3] basis, the concentrations of milk constituents which make a major contribution to these colligative properties. The prospect that a knowledge of such relationships might help in the understanding of the processes of milk secretion and in the explanation of the natural variations in milk composition has encouraged the extension of earlier observations[1–3] and from the results a more general relationship has been derived.

The constituents known to play a major part in the control of the osmotic properties of milk are sodium and potassium, with their associated anions, and lactose. One hundred and four samples of milk, taken over a period of three months from twelve Shorthorn cows in mid-lactation, were therefore analysed for sodium, potassium, lactose and water and the concentrations (C) expressed in mgm./100 gm. of water. The interrelationships of these were studied by the technique of multiple regression analysis, with the following results:

Sodium.

$$C_{Na} = 343{\cdot}7 - 0{\cdot}393\,C_K - 0{\cdot}0411\,C_{lactose} \quad (1)$$

The partial regression coefficients of sodium on potassium and on lactose are both very highly significant ($P < 0.001$).

Potassium. A corresponding analysis of the multiple regression of potassium on sodium and lactose showed that the partial regression coefficient of potassium on sodium was very highly significant, but that on lactose non-significant. The simple regression of potassium on sodium was:

$$C_K = 230.9 - 0.933\, C_{Na} \quad (2)$$

This is very highly significant ($P < 0.001$).

Lactose. An analysis of the multiple regression of lactose on sodium and potassium showed that the partial regression coefficient of lactose on sodium was very highly significant but that on potassium non-significant. The simple regression of lactose on sodium was:

$$C_{lactose} = 5{,}785 - 9.32\, C_{Na} \quad (3)$$

This is very highly significant ($P < 0.001$).

The interrelationships of the three constituents are defined by equation 1 and the relationships expressed in equations 2 and 3 suggest that sodium in milk may be considered to be derived from two sources, a part associated with potassium and the remainder associated with lactose. Thus the water secreted in milk can be represented as a two-phase system: in one, referred to as the sodium–lactose phase, potassium is absent and sodium and lactose vary inversely; in the other, a sodium–potassium phase, lactose is absent and sodium and potassium vary inversely. This concept may be of value in the interpretation of natural variations in the concentrations of other milk constituents. The proportions of these two phases in milk, at least in the samples analysed, must be fairly constant, since variations in potassium and lactose were almost wholly independent.

If, in equation 1, two of the three variables are made equal to zero in turn, the concentration of the third variable in a 'theoretical milk' from which the other two are absent can be calculated to be:

$$C_{Na}, 343.7\ ;\ C_K, 874.6\ ;\ C_{lactose}, 8{,}372$$

The corresponding figures calculated for solutions isotonic with milk of sodium or potassium, with a monovalent anion, or of lactose are:

$$C_{Na}, 327.7\ ;\ C_K, 557.1\ ;\ C_{lactose}, 9{,}754$$

Agreement between the two figures for sodium is good, but the high figure derived for potassium suggests that potassium in milk is either incompletely ionized or associated largely with trivalent anions. The synthesis of materials such as citric acid within the mammary gland would account for the lactose figure being less than the theoretical.

From these figures derived for potassium and lactose and those obtained from equations 2 and 3 respectively when sodium is made equal to zero, the average division of the water of milk between the two hypothetical phases can be calculated to be:

sodium–lactose phase, 69·1 per cent;
sodium–potassium phase, 26·4 per cent.

The accumulation of analytical errors and the exclusion of the effects of other osmotically active materials could satisfactorily account for the fact that the two figures total only 95·5 per cent.

The following equation can also be derived from equation 1:

$$H_2O_{(gm./100\,gm.\ of\ milk)} = 0.2909\ Na_{(mgm./100\ gm.\ of\ milk)} + 0.1143\ K_{(mgm./100\ gm.\ of\ milk)} + 0.01195\ lactose_{(mgm./100\ gm.\ of\ milk)} \quad (4)$$

Using this equation to predict the water contents of each of the milk samples analysed, the standard deviation of the differences between predicted and observed water values was ± 1.62 gm., on a mean value of 87·5 gm. water per 100 gm. of milk. Analysis of variance showed that there were highly significant differences in the accuracy of prediction of water content of the milk of different cows. Thus, the constants of the various equations must vary from cow to cow.

These results are highly promising and the investigation will now be extended to the milk of other breeds of dairy cattle, to milk obtained very early or late in lactation and to the milk of cows infected with mastitis, in an attempt to clarify further these basic relationships.

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March 19.

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Carbon Dioxide Fixation in Some Components of Growing Rat Red Cells

The incorporation of carbon-14 dioxide from carbonate into rat erythrocytes has been described by Schubert *et al.*[1]. This communication is concerned with carbon dioxide fixation in the following components of rat erythrocytes: ghosts, hæmoglobin, globin and hæmatin.

The rats (approximately 100 gm. in weight) were given intraperitoneally 1 ml. of $NaH^{14}CO_3$ solution, made isotonic with sodium chloride and containing 120 μc. of carbon-14. On the eighth day after the injection the rats, anæsthetized and heparinized, were killed by slitting their throats. Red cells were collected and washed several times with saline, then hæmolysed. The insoluble residue of ghosts was separated by centrifugation and washed four times with saline. From the soluble fraction, previously acidified (0·05 *N* in hydrochloric acid), hæmoglobin, globin and hæm were prepared by methods described by Anson *et al.*[2]. All these substances were dried at 100° C. Measurements of total carbon were made on 20 mgm. of dry substances by the wet combustion method, with manometric measurements of the carbon dioxide evolved according to Van Slyke *et al.*[3] The carbon dioxide was transferred to the gas phase Geiger–Müller counter (the counters were of approximately 100 ml. volume, 1 in. in diameter, with 3·6 mil. tungsten centre wire). The filling gas was ethanol vapour (1 cm. mercury) and carbon dioxide (8–15 cm. mercury). The efficiency of the counter was 53 per cent. The working voltage was 3,000–4,000 V., which increased with carbon dioxide pressure. The plateau characteristics were: 300–400 V. of length and 4 per cent per 100 V. of slope. A quenching circuit of 400 μsec. was employed. The counter was shielded with lead 2 in. thick. The

Table 1

Substance	No. of experiments	Specific activity (disintegrations/mgm./min.)
Ghosts	2	14·6 ± 0·4
Hæmoglobin	2	10·7 ± 0·4
Globin	5	9·7 ± 0·3
Hæmatin	4	3·6 ± 0·2

number of total counts—minus background—was at least 1,000 for every sample.

The results are given in Table 1.

A widespread incorporation of carbon-14 from bicarbonate is evident in all substances, but its magnitude varies. The smallest specific activity was found in hæmatin: this is probably due to the fact that only the carbons in position 10, and perhaps 3–5, of the pyrrole rings (derived from —COOH groups of succinate) are radioactive.

In globin there are several amino-acids that could incorporate carbon dioxide: glycine, alanine, aspartic acid, glutamic acid, arginine and proline. Of these, arginine probably is the most radioactive, just as in the proteic fraction of liver and muscles[4].

In the ghosts, the greater specific activity is probably due to the proteic fraction and particularly to arginine molecules.

Further experiments are in progress to extend these results.

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In Vitro Study of Cartilage Induction in *T/T* Mice

A large number of mutations (more than 20) have been demonstrated in the complex locus *T* in linkage group IX of the house mouse[1]. Those mutations which have been studied embryologically appear to affect processes concerned with the formation and subsequent differentiation of the notochord–mesoderm system and its developmental dependent, the neural tube. The *T/T* embryos develop essentially normally through early somite stages, but at about the 4-somite stage there begin prothannic changes which result in an embryo entirely lacking the posterior portion of the body, and having no notochord, only remnants of somites and a neural tube both structurally and cellularly abnormal. This condition is clearly due to some interference with the processes of axial organization, but it has been impossible to define with descriptive methods which of these developmentally related structures is primarily affected by the mutation.

This communication is a preliminary report of an attempt to elucidate these disturbed inductive relationships by means of organ culture. Experiments on normal 9-day mouse embryos by Grobstein and Holtzer[2] have demonstrated that, in tissue culture, cartilage differentiation in somites of this stage is dependent on an inductive stimulus from the neural tube. It seemed that this system offered a way to test the condition of at least two of the defective components in *T/T* embryos, the neural tube and the somites.

The technical procedure was as follows. The normal embryos used were all between 18 and 22 somites; *T/T* embryos cannot be 'staged' by somite number, but those used for cultures were all litter mates of the normal embryos used. Somites and neural tube were isolated after treatment with 2 per cent trypsin. The cultures were set up at the glass-clot interface in a standard clotting mixture of one part medium (40 per cent Tyrode's solution, 40 per cent horse serum, 20 per cent chick embryo juice) to one part chicken plasma. An approximately constant mass of somites was always arranged in a ring around the piece of ventral spinal cord used as inducer. The experimental plan and its results are given in Table 1.

Table 1

Under test	Type of culture	Result	No. of cultures*
Autonomous or non-autonomous development of *T/T* rudiments	*T/T* neural tube × *T/T* somites	no cartilage	(9/9)
Inductive potency of *T/T* neural tube	*T/T* neural tube × +/+ somites	cartilage	(26/30)
Ability of *T/T* somites to respond to normal inducer	+/+ neural tube × *T/T* somites	no cartilage	(21/22)
Ability of *T/T* genotype to support cartilage formation	*T/T* anterior limb buds	cartilage	(10/11)
Control for adequate conditions for cartilage formation	+/+ neural tube × +/+ somites	cartilage	(36/40)
Control to test condition of +/+ somite mesoderm	+/+ somites	no cartilage	(16/18)

* Numerator refers to the number of cultures conforming to the specified result, denominator indicates total number of cultures.

The significant observations are that *T/T* neural tube, which is abnormal both in gross and microscopic structure, remains an effective inducer of cartilage in normal somites, while *T/T* somites, which often were still of normal appearance when put into culture, appear to be totally unable to respond with the production of cartilage to the inductive influence of normal neural tube. What causes the inability of somite material to differentiate is, however, still not clear. *T/T* limb buds cultured under the same conditions produced normal cartilage, a fact which demonstrates that there is no fundamental biochemical block to cartilage formation in these embryos. Thus the failure of cartilage induction in somites may be the result of a defect specifically in the somite mesoderm, or more likely it may be a reflexion of organizer relationships which were disturbed in such a way that the somites did not receive some normal 'pre-inductive' stimulus, perhaps dependent on the notochord, which may be necessary before they are prepared to respond to the induction by the neural tube. Further experiments on this question are being carried out.

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Relict *Rotlehm* in Northern Ireland

GRANODIORITES decomposed to a depth of some 20 ft. have been noted during a recent examination of abandoned quarries on the southern slopes of the Slieve Croob Mountains in County Down[1]. The decomposed or rotten granodiorite is obviously *in situ*, as thin veins of more resistant rock can be seen passing upwards from the unweathered rock at the base of the sections through the upper rotten material to the surface. In many cases it is clear that the weathering which produced these deposits has proceeded most vigorously down the joints and along the pseudo-bedding planes in the granodiorite, often leaving core-stones entirely surrounded by weathered rock. The weathered material is often brownish-yellow in colour, sandy or gravelly in texture, and is usually overlain by hill-wash of uncertain date. However, in a section near Greerans Close (Irish Grid ref. 255 428) the 6 ft. of weathered material visible is bright red in colour (Munsell 10*R* 4/6 on air-dry samples), but morphologically and texturally it is similar to that described above. At all the sites spheroidal weathering is weakly developed but the deposits resemble published descriptions and photographs of the growan and buried tors on Dartmoor, the saibro of Portugal[2] and, to a lesser extent, the tropical soils illustrated by King[3], and Mohr and van Baren[4].

Thin sections of the weathered material from Greerans Close have been prepared using techniques described by Rowland and Lewis[5] and Dalrymple[6]. Sections were difficult to prepare because of the friable nature of the material and the dense character of the whole soil, which was unequally transparent in thin section. In reflected light, sections are intensely red from the dispersion of ferric hydroxide in the ground mass. In thin section the mineral grains are seen to be surrounded by dense red or reddish-brown deposits, while the ground mass is generally paler in colour. The fabric tends to be spongy with occasional dark flecks and concretions in it. The thin sections examined suggest that the material at Greerans Close is the remains of the (*B*) horizon of a *Rotlehm*, perhaps of *Earthy Rotlehm* type (Kubiëna)[7]. More precise identification has not yet been possible, but comparison with slides in the type collection of the Institute of Archæology, University of London, supports this identification.

It is not certain whether the deposit partly overlying the *Rotlehm* at Greerans Close is boulder clay, but there is no doubt that the red material is *in situ*. Elsewhere it forms the modern soil and is therefore to be regarded as a relict soil (Kubiëna)[8]. Deposits of similar colour but more clayey in texture, which are not necessarily *in situ*, have been noted in deep clefts developed along the joints in the granodiorite of Slievenaboley Mountain, at a height of 900 ft., where ice action has smoothed and grooved the rock surface. Preliminary field mapping suggests that the rotten granodiorites, whether red as at Greerans Close or brownish-yellow as elsewhere, occur at least intermittently over an area of some three square miles. They are found at a height of 700–800 ft. on the shoulders of the north–south valley which separates Deehommed (Irish Grid ref. 252 424) and Slievenaboley (Irish Grid ref. 269 425) and along the southern flanks of these two mountains, and of Cratlieve to their east (Irish Grid ref. 296 446).

The date of the deposits is uncertain. They are certainly not post-glacial in origin, for the depth of weathering contrasts markedly with the fresh appearance of glaciated granodiorite surfaces only a few hundred yards distant from them. The *Rotlehm* characteristics of the Greerans Close deposit suggest a very much warmer climate than the present, unless the view of Carter and others[9] that such characteristics might be due to long periods of weathering is correct. Whichever of these views is accepted, it seems certain that the weathered materials described here are relics of at least Great Interglacial, or perhaps more likely, of Tertiary date. As such, they are an important addition to the already published sites where similar deep weathering has been observed[10]. Attempts to obtain pollen, which might provide a clue as to date, from samples collected at Greerans Close, have unfortunately not been successful.

Work is continuing on the mapping and mineralogy of these deposits. I am indebted to Prof. E. E. Evans, Mr. F. W. Boal and Mr. N. S. Angus (The Queen's University, Belfast) and Dr. I. W. Cornwall (Institute of Archæology, University of London) for helpful discussion on this material.

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Candida albicans from Grass Leaves

Candida albicans (Robin) Berkhout was recovered from a sample of grass leaves in the course of an examination of yeasts from the phyllosphere of pasture grasses. The sample, which was taken in December from an area that was lightly stocked with sheep, consisted of leaves of perennial ryegrass, white clover and flatweeds. Dilutions of the grass were made in 0·05 per cent (w/v) peptone water, plated on to acidified glucose peptone agar, and incubated at room temperature. Fifty yeasts were subcultured and identified, and three of these were the pathogen.

The three isolates were very similar morphologically. Pseudomycelium and chlamydospores were produced freely on potato glucose agar, but streak cultures on solid media were soft, unwrinkled and of the *S* type. Glucose, maltose and galactose were fermented and glucose, sucrose, maltose and galactose assimilated. A rabbit, inoculated intravenously with 50 million cells of a day-old culture of one of the strains, died within two days. The kidneys showed numerous pinpoint abscesses which contained budding cells and pieces of pseudomycelium. *Candida albicans* was recovered from cultures of kidney fragments.

This is the third report of the recovery of *Candida albicans* from a vegetable source. Negroni and Fischer[1] isolated it from rotting vegetation, and van Uden, de Matos Faia and Assis-Lopes[2] found three

strains on shrubs, two on furze flowers and one on myrtle leaves. Van Uden *et al.* did not consider that plant materials were a natural habitat for *C. albicans*, but thought that in this situation the pathogen was a contaminant with prolonged powers of survival. All evidence in my past and present findings suggests that *C. albicans* is not a true member of the phyllosphere flora. Yeasts from this habitat are almost invariably non-fermenting and are either mucoid in consistency or pigmented. Sources of contamination are common in New Zealand, and Parle[3] found *C. albicans* in the alimentary tracts of sheep, dogs, hedgehogs and Australian opossums, all of which had access to the area from which the grass sample was taken.

It now seems probable that *Candida albicans* occurs commonly on vegetation, for surveys of yeasts from this habitat are made infrequently. Even if this is so, it is unlikely that contaminated grass is a hazard to public health. Up to 50 per cent of normal humans carry the yeast in their alimentary tracts[4] and exposure to it, in small numbers, must be a daily experience. Clinical and experimental studies suggest that host factors, such as disturbance of the normal flora or weakening of body defences, may play a part in causing *C. albicans* to behave as a pathogen rather than as a saprophyte.

I am indebted to Mr. J. C. Percival, Ruakura Animal Research Station, Hamilton, who collected the grass sample.

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Transmission of Juvenile Rooting Ability from Seedlings to Adults of *Hevea brasiliensis*

The Para rubber tree, *Hevea brasiliensis* (Willd. ex A. Juss.), is notoriously difficult to propagate from cuttings. Previous reports[1] have shown that cuttings from the bases of young trees root readily, whereas cuttings from the branches of mature trees do not. The formation of adventitious shoots in prone trees and the rooting of cuttings from these shoots has been described[2].

As Robbins[3] has pointed out, grafting of adult stems on seedlings of many different kinds of plants has induced a juvenile type of growth in the adult scion. Attempts were made to induce juvenility and thereby enhance rooting ability in *Hevea* by grafting buds from a mature *Hevea* clone (Tjirandji 1) on seedling plants.

Buds were taken from branches of 8–10-year-old trees and grafted at the base of stems of 12-month-old seedlings. The method of budding has been previously described[4]. When the bud had sprouted and grown 3–5 ft., cuttings were made and planted under a mist spray. At the same time, buds were taken from the sprouts and grafted to other seedlings. This sequence of budding and planting cuttings was repeated four times. 30 per cent of the cuttings from scions of the fourth and fifth graftings formed roots in about eight weeks after planting under the spray, but cuttings from the original clone and from the first, second and third graftings failed to root.

Fresh basal sections from seedling stems were ground and extracted with water, alcohol or ether. These extracts were used to treat other cuttings and air-layers but failed to improve the rooting ability of the adult plant.

These results are further evidence that the juvenile form may transmit a substance to the adult which induces the adult to assume juvenile characteristics. They suggest that if a substance is actually transmitted from stock to scion that this material is not readily soluble in ordinary solvents, but that it may be slowly absorbed and accumulated by the scion in sufficient amounts to induce a change in rooting ability.

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Ion Permeability of the Plasmalemma of the Plant Cell

In an earlier communication[1], I advanced evidence for the existence, in *Nitella*, of a plasmalemma with limited ion permeability. This evidence has been questioned by Prof. G. E. Briggs[2].

He suggests a model *Nitella* cell in which the tonoplast is the only membrane, and says that this model is consistent with the results of my d.c. resistance measurements. He argues for his model that "if the tonoplast is practically impermeable to cations, then the conductivity of the cytoplasm . . . will depend on the concentration and mobility of anions in (this phase)". This is clearly incorrect. In such a model the cytoplasm would have a very high conductivity (it would contain 0·8 *M* cations if univalent). This high conductivity would not be modified by the presence of a tonoplast impermeable to cations. The flow of current would, on Prof. Briggs's model, produce a large potential gradient across the tonoplast and a small potential gradient across the cytoplasm. His model is therefore inconsistent with the results, as is any model containing a tonoplast alone. A structure responsible for the greater part of the d.c. resistance of the cells must lie between the bathing medium and the inner cytoplasm. It is difficult to doubt that this is the plasmalemma.

With reference to the determinations of calcium activity, the pond water used was filtered. Similar results were also obtained on cells in calcium chloride solutions. The method (including the use of flowing external solution) was as previously reported[2]. The potential difference between the cytoplasm and the pathing medium (E_{co}) was measured, and the calcium chloride concentration ($[Ca^{++}]_o$) in the latter was known.

E_{co} measured	−140 mV.	−144 mV.	−137 mV.
a_oCa^{++} known (≒ $[Ca^{++}]_o$)	0·5 m*M*	0·5 m*M*	0·05 m*M*
a_oCa^{++} calculated if there is Ca^{++} equilibrium	34 *M*	46 *M*	2·7 *M*
Time allowed for equilibrium	20 min.	22 hr.	2 hr.

Here, as previously[1], a_oCa^{++} is calculated from the equation (wrongly given in my earlier communication):

$$a_{cj} = a_{oj}\, 10^{(-Z_j E_{co}/58)}$$

The calculated activity of calcium ions in cytoplasm is again impossibly high.

It is true, as Prof. Briggs has said, that the results for calcium give no information as to the mode of entry of calcium into the cell. From the striking absence of equilibrium, I concluded[1] only that a plasmalemma of limited permeability to calcium was most probably present. As reference to the earlier communication will show, the suggestion of a lipid plasmalemma containing ion carriers was made to reconcile the following results obtained on *Nitella*: (*a*) radioactive cations appear to cross the plasmalemma much more rapidly than the tonoplast[4]; (*b*) the plasmalemma has a much higher electric resistance than the tonoplast[1].

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My statement, quoted by Mr. Walker, would be a *non sequitur* if "impermeable to cations" could be said not to imply permeability to anions. It is incorrect only if the alternative, the conductivity is independent of the concentration of anions, is correct. Mr. Walker can scarcely be maintaining this alternative.

I ought to have made it clear explicitly that I was referring to ohmic resistance both in my statements and in my calculation of the concentration of anion from the resistance of the cytoplasm. There would be a polarization resistance in the cytoplasm as well as that in the tonoplast. Mr. Walker's communication implies only the latter.

Mr. Walker has now provided more convincing evidence that the cytoplasm of *Nitella* and the external solution equilibrate very slowly with respect to calcium.

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Slide Gel Diffusion Precipitin Test

A modification of the plate gel diffusion test[1] is proposed, carried out on microscope slides. The use of a thin layer of media on the slide, together with a reduction in the distance between antigen and antibody basins, resulted in an earlier appearance of the reaction.

Ordinary new microscope slides were cleaned and polished with methyl alcohol and inspected for freedom from scratches, etc. Two lines, 4 cm. apart, were drawn on a slide with a grease pencil (alternatively two thin strips of zinc oxide tape were used) to limit the spread of the medium on the slide and thus obtain a reasonably constant depth of medium (approximately 0·16 cm.). This left 1½ cm. at one end of the slide which accommodated a type-written zinc oxide label identifying the individual slide. The bottom part (2 cm.) of the slide was left free for handling during reading.

Stock medium for this technique was the same as that used formerly[1]. Small quantities, stored in universal bottles with screw caps placed in a water bath at 64° C., were renewed weekly, thus avoiding the necessity of either preparing media in small quantities or remelting already congealed media. The melted media were distributed with a Pasteur pipette in 1-c.c. amounts between the two lines.

The cutting instrument consisted of a small 'Perspex' sheet in which the hexagonal pattern of two precipitin units were drilled, the distance between one basin and another within the same unit being 0·15 cm. The 'Perspex' sheet was made to fit over the prepared slide. Basins were cut by pushing a stainless steel tube, possessing a sharp edge, through holes drilled in the 'Perspex'. Prepared slides, which were kept in Petri dishes, were used preferably within a day or two, but they could be used after a longer period (1 week) if kept at 4° C.

The reagents were placed in the basins using a specially prepared small-bore pipette, as was done in the plate test. For convenience a pipette was fixed in the cap of a 10-c.c. bottle containing the specific serum, and in most cases where antigen was used as a suspension (for example, *Brucella*, *E. rhusiopathiae*, or an exudate such as myxoma). Slides in Petri dishes were incubated at 37° C.

The results were read and recorded as in the plate technique[1]. It was noticed that when slides were used the results were better when read as soon as the reactions were expected to appear, depending on the particular antigen–antibody system used. If slides were left for a longer period before being read some of the lines became blurred. It was possible by this method to demonstrate the precipitin reaction in a shorter time than when plates were used. Table 1 shows results obtained when the same reagents were used with both techniques at the same time. Four known viral and three bacterial antigen–antibody systems were used and the results shown were based on thirty-eight identical exposures of each antigen and its antibody.

An example of the slide technique is shown in Fig. 1. The slide on the left shows the result obtained after being left 18 hr. at room temperature, whereas that on the right shows the result obtained 90 min. after preparation of the slide. With each unit comprising six basins and each basin numbered in a clockwise direction 1 to 6 commencing at 12 o'clock,

Table 1

Antigen–antibody system	Plate		Slide	
	Minimum time of appearance	Maximum time of appearance	Minimum time of appearance	Maximum time of appearance
Viral:				
Canine distemper complex	5 hr.	Overnight	1 hr.	3 hr.
Canine hepatitis or Rubarth's disease	7 hr.	Overnight	3 hr.	4 hr.
Myxomatosis	1 hr. 50 min.	5 hr.	45 min.	1 hr.
Swine fever	3 hr.	Overnight	1 hr. 30 min.	2 hr. 10 min.
Bacterial:				
Brucella melitensis	5 hr.	Overnight	1 hr. 25 min.	2 hr. 30 min.
Cl. welchii D.	3 hr.	Overnight	1 hr. 40 min.	3 hr.
E. rhusiopathiae	5 hr.	Overnight	1 hr. 25 min.	3 hr.

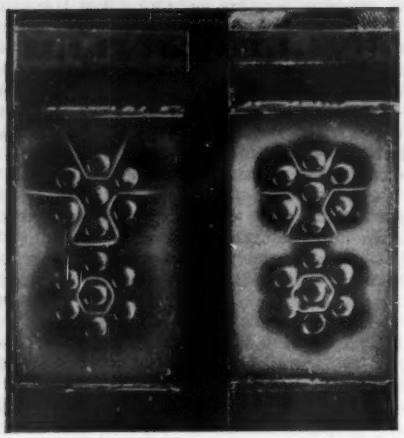

Fig. 1

the arrangement of the reagents in all four units were: convalescent myxoma serum in the centre basin, and myxoma exudate antigen in basins 1, 3 and 5. In the upper two units myxoma convalescent serum was added to basins 2, 4 and 6 and in the lower two units myxoma exudate antigen was placed in basins 2, 4 and 6.

The advantages of this technique are rapidity and economy of reagents, making it possible to proceed when the specimen submitted is insufficient for a plate test.

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Use of Electronic Flash in Photomicrography

Other workers (Wilson[1] and Doncaster[2]) have discussed methods of incorporating electronic flash in microscopy; but both of them exposed the tube and no attempt was made to limit and concentrate the light from the flash tube on to the microscope mirror. A large amount of light is lost in this way, and Doncaster[2] noted that with high powers (4-mm. objective) of the microscope, high-speed film had to be used with the consequent disadvantage of large grain. In the method to be described, the electronic flash as illuminant is incorporated in an optical bench and an attempt has been made to concentrate the flash on to the microscope mirror so that fairly critical illumination is attained.

The flash unit used is the Courtenay 'Magna II *E*' with a rating of 220 Joules and a flash duration of approximately 1/4,000 sec. The flash tube, with its reflector removed, is inserted into a special reflector unit (Fig. 1) placed on a horizontal optical bench between microscope and microscope lamp. The tube rests on a *T*-piece, the vertical arm of which is attached to the side of the box *A*. Dimensions must be modified to suit individual arrangements. The actual reflecting surface of the unit consists of a

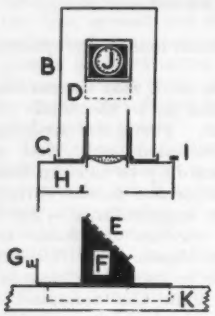

Fig. 1

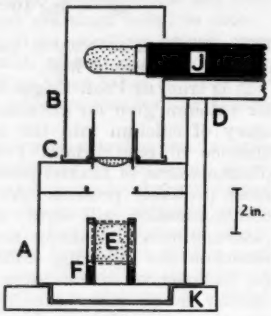

Fig. 2

Fig. 1. Reflector unit, side elevation: *A*, wooden box; *B*, metal cylinder; *C*, flange bearing tubular focusing unit with 2-in. plano-convex condenser; *D*, arm holding flash; *E*, coverslip; *F*, coverslip support; *G*, filter holder for microscope; *H*, shelf holding illumination control filters; *I*, front panel sliding in groove; *J*, flash tube; *K*, optical bench

Fig. 2. Reflector unit, front elevation

No. 2 ($2\frac{1}{2}$ in. × $1\frac{3}{4}$ in.) coverslip mounted on two wooden supports and inclined at an angle of 45°. This coverslip lies between four pins and is held in position by elastic bands stretched across the top and bottom pairs of pins so that the coverslip is easily removed for cleaning or replacement. The transparent reflector allows the greater portion of the microscope-lamp beam to pass through and will also, in conjunction with the black background, deflect the flash beam on to the microscope mirror. The interior of the unit is painted matt black.

The optical bench, *K*, is first arranged so that the image of the microscope lamp filament comes to lie in the plane of the object on the microscope stage. The reflector unit is then introduced on to the bench and the flash tube replaced by a 240-V. lamp of the same dimensions. The microscope lamp is switched off and the condenser and the distance between reflector unit and microscope is adjusted until this second lamp image is also in focus in the same plane as the image of the microscope lamp. The unit is fastened to the optical bench and the flash tube replaced in tube *B*. The flash is synchronized at 1/50 sec. to a single-lens 35-mm. reflex camera. The camera extension is approximately 3 in. and with the medium ($\frac{3}{4}$ in.) and high ($\frac{1}{2}$ in.) powers of microscope objective the illumination is too intense and has to be reduced with normal monochromatic and/or neutral density filters placed on shelf *H*. Filters for normal visual work with the microscope are placed in rack *G*. With fresh material and, using the $\frac{3}{4}$ in. × 10 combination, Ilford filters 303 plus 404 were required; with $\frac{1}{2}$ in. × 10, filter 104 was used. No filter was required with $\frac{1}{2}$ in. × 10 combination. The film was rated at *A.S.A.* 25 and developed in *I.D.* 2 for 6–7 min. at 20° C. For low-power work it was found necessary to switch the microscope lamp off before releasing the flash to avoid double exposures. The lamp was wired to a foot switch, thus freeing the hands for focusing and shutter release.

David A. Erasmus

Department of Zoology,
University College,
Cardiff.
March 3.

[1] Wilson, D. P., *Discovery*, **14**, 347 (1953)
[2] Doncaster, C. C., *Nematologica*, **1**, 51 (1956).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 5

LABORATORY ANIMALS CENTRE (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 9.30 a.m.—Symposium on "The Organization and Administration of an Animal Division". Chairman: Sir Charles Harington, F.R.S.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 5 p.m.—Annual General Meeting. Mr. F. J. M. Laver: "Automatic Data Processing Equipment—an Introduction to its Techniques and Applications".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr. B. A. Stone: "The Biochemistry of Cellulose and Related Polysaccharides".* (Further lecture on May 12.)

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. R. Huisgen (Munich): "Recent Contributions to the Organic Chemistry of Nitrogen".*

BRITISH GLACIOLOGICAL SOCIETY (at Bedford College, Regent's Park, London, N.W.1), at 6 p.m.—Annual General Meeting, followed by Mr. J. A. Heap: "Glaciology in the Modern World".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Annual General Meeting.

Tuesday, May 6

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, London, W.C.2), at 5 p.m.—Prof. D. V. Glass: "Education".* (Fifteenth of a series of lectures on "Law and Opinion in England in the Twentieth Century". Further lectures on May 13 and 20.)

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. A. T. Starr: "Some Case Histories of Business Computers in the U.S.A.".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. R. S. Nyholm: "What is Meant by Oxidation and Reduction". (Lecture for Sixth Form Pupils from Schools in London and the Home Counties. To be repeated on May 8, 13 and 15 at 5.30 p.m.)

PLASTICS INSTITUTE, LONDON AND DISTRICT SECTION (at the Wellcome Building, 183–193 Euston Road, London, N.W.1), at 6.30 p.m.—Dr. N. J. L. Megson: "Modern Ideas on Polymer Formation and Degradation".

Wednesday, May 7

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. W. L. Smith: "Renewal Theory and its Ramifications".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. P. G. W. Hawksley, Mr. S. Badzioch and Mr. J. H. Blackett: "Improved Sampling Equipment for Solids in Flue Gases".*

INSTITUTE OF PETROLEUM (at 61 New Cavendish Street, London, W.1), at 5.30 p.m.—Mr. W. J. Newby: "Recent Developments in Refining".

ASSOCIATION OF CLINICAL BIOCHEMISTS, SOUTHERN REGION (joint meeting with the SOCIETY OF ANALYTICAL CHEMISTRY, in the Meeting Room of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Symposium on "Electrophoresis in Clinical Biochemistry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Solly Zuckermann, F.R.S.: "How Light Affects the Breeding Activities of Seasonal Animals".

Wednesday, May 7—Thursday, May 8

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 2.45 p.m. on Wednesday and 10 a.m. on Thursday—Annual General Meeting.

Thursday, May 8

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. M. Jones: "Enzymatic Oxidation of Protein as a Rate Determining Step in the Formation of Highly Stable Surface Membranes"; Mr. R. Dennell: "The Amino Acid Metabolism of a Developing Insect Cuticle: the Larval Cuticle and Puparium of *Calliphora vomitoria*, Parts 1–3".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. S. M. Manton, F.R.S.: "Some Principles of Leg Design in Arthropods illustrated by Working Models"; Dr. D. A. Parry: "The Jumping of Salterid Spiders".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. P. T. Standring: "Artificial Fibres".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. Dr. R. Huisgen (Munich): Heinrich Wieland Memorial Lecture.

Friday, May 9

BRITISH MYCOLOGICAL SOCIETY (in the Large Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Applied Acoustics" opened by Mr. G. Mather.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (with experience in teaching in secondary schools, and either a degree in zoology or a wide knowledge of animals) IN THE EDUCATION DEPARTMENT, for duties which will consist mainly of giving talks on zoological topics to secondary school pupils—The Secretary, Zoological Society of London, Regent's Park, London, N.W.1, quoting Ref. "Education" (May 9).

INSPECTOR OF SALMON FISHERIES (with an honours degree (science), and preferably research experience in freshwater fisheries or related subjects or experience in superintendence of a freshwater fishery)—Establishment Officer, Scottish Home Department, St. Andrews House, Edinburgh 1 (May 9).

SENIOR LECTURER (with high academic qualifications, and able to teach to special (honours) degree standard) IN MATHEMATICS—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (May 9).

LECTURER, Grade B (with an honours degree and competent to teach the subject to degree standard), IN MATHEMATICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (May 10).

LECTURER (with a good physics degree and industrial and teaching experience) IN PHYSICS at Victoria Institute (College of Further Education), Worcester—The Director of Education, 13 High Street, Worcester (May 10).

SENIOR LECTURER (with a good honours degree and experience in industry, teaching or research, and preferably the ability to teach electronics) IN PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan, quoting Ref. No. 8151 (May 12).

RESEARCH FELLOW IN ORGANIC CHEMISTRY—The Secretary, The Queen's University, Belfast (May 15).

ASSISTANT LECTURER, Grade B (with good academic qualifications and experience in experimental and theoretical physics), IN THE DEPARTMENT OF PHYSICS—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (May 16).

PRINCIPAL LECTURER IN EDUCATION with responsibility for promoting and co-ordinating research in technical education; a PRINCIPAL LECTURER to assist with the organization of courses for full-time teachers serving in technical colleges; a PRINCIPAL LECTURER qualified in engineering; and a PRINCIPAL LECTURER qualified in science, preferably in physics, at Bolton Training College for Teachers of Technical Subjects—Chief Education Officer, Education Offices, Nelson Square, Bolton (May 17).

LECTURER (with special qualifications in organic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, King's College (University of Durham), Newcastle-upon-Tyne (May 19).

PRINCIPAL SCIENTIFIC OFFICER (with an honours degree in mathematics or other academic qualifications and research achievements considered the equivalent) at the Weapons Research Establishment of the Department of Supply, Salisbury, South Australia, to initiate and be responsible for research, especially of a mathematical nature, in supersonic and transonic flow, and to collaborate with staff carrying out experimental work in this field; and to exercise supervision over the work of other scientific staff—The Senior Representative (A.P.91), Department of Supply, Australia House, Strand, London, W.C.2 (May 19).

LABORATORY SUPERINTENDENT (with considerable experience as an engineering laboratory technician, preferably in a university or college of technology) OF THE ENGINEERING LABORATORIES; a LECTURER IN APPLIED MATHEMATICS; LECTURERS (2) IN PHYSICS; and a LECTURER IN CHEMISTRY at Fourah Bay College (University of Durham), Sierra Leone—The Council for Overseas Colleges, 12 Lincoln's Inn Fields, London, W.C.2 (May 20).

ASSISTANT LECTURER, Grade B (with good academic qualifications), IN BOTANY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (May 24).

LECTURER IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Edinburgh (May 24).

READER IN PHYSICAL METALLURGY at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 27).

ASSISTANT LECTURER IN PHYSICS—The Registrar, The Manchester College of Science and Technology, Manchester 1 (May 31).

CONSERVATION OFFICERS (with, or obtaining this summer, a degree in agriculture) IN THE DEPARTMENT OF CONSERVATION AND EXTENSION, Federation of Rhodesia and Nyasaland—The Secretary (R), Rhodesia House, 429 Strand, London, W.C.2 (May 31).

EMPIRE RHEUMATISM COUNCIL FELLOW (with medical or scientific qualifications) to prosecute research in the field of rheumatism—The General Secretary, Empire Rheumatism Council, Faraday House, 8–10 Charing Cross Road, London, W.C.2 (May 31).

LECTURER or ASSISTANT LECTURER IN BIOCHEMISTRY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 31).

TUTOR (graduate in geography), and a MAP CURATOR (preferably graduate in geography) IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Liverpool (May 31).

ASSISTANT IN PHYSIOLOGY—The Secretary of University Court The University, Glasgow (June 2).

LECTURER IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (June 2).

LECTURER or SENIOR LECTURER (male, British subject, with a first- or second-class honours degree in mathematics, and preferably some teaching experience) IN THE MATHEMATICS DEPARTMENT—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (June 9).

ASSISTANT DIRECTOR (with a good science degree, and a knowledge of dairy science, information and abstracting work, and one or more foreign languages) OF THE BUREAU OF DAIRY SCIENCE AND TECHNOLOGY, Shinfield, near Reading, Berkshire—The Secretary, Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Bucks (June 30).

LECTURER IN PHILOSOPHY at the University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 1).

ASSISTANT IN RESEARCH (graduate in mathematics, mathematical statistics or statistics, or expecting to graduate in the coming summer) IN THE DEPARTMENT OF HUMAN ECOLOGY—Dr. G. A. Gresham, Secretary of the Appointments Committee of the Faculty of Medicine, The Medical School, The University, Tennis Court Road, Cambridge (July 30).

PROFESSOR OF PHILOSOPHY at the University of Tasmania, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

ASSISTANT PROFESSOR, and an INSTRUCTOR IN THE DEPARTMENT OF MATHEMATICS—Dr. H. H. Ferns, Department of Mathematics, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

BOTANIST (preferably male between the ages of 23 and 32, with a good honours degree in botany and postgraduate training or experience in plant breeding) at the Rice Research Station, Rokupr, Sierra Leone, to investigate general botanical problems connected with rice growing in West Africa—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/15/014.

CHAIR OF BIOCHEMISTRY in the Faculty of Medicine—The Dean, Faculty of Medicine, The University of Manitoba, Emily and Bannatyne, Winnipeg 3, Manitoba, Canada.

DEMONSTRATOR (with, or expecting to obtain this year, an honours degree in botany) IN THE BOTANY DEPARTMENT, to assist in practical classes in elementary botany and to undertake research on water relations in field conditions—The Professor of Botany, Imperial College, Prince Consort Road, London, S.W.7.

LECTURER, Grade B (honours graduate of a British university, and preferably with some research or industrial experience) IN PHYSICS—The Clerk to the Governing Body, Battersea College of Technology, London, S.W.11.

PHYSICIST (honours graduate), for novel and stimulating work on neutron diffraction involving research with neutrons in an unexplored field—Group Recruitment Officer (1106/34), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

RESEARCH ASSISTANT IN INORGANIC CHEMISTRY, to engage in research in the field of co-ordination chemistry with a view to preparing for the Ph.D. degree (University of London, Internal)—Head of the Department of Chemistry, Chelsea College of Science and Technology, Manresa Road, London, S.W.3.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in an appropriate subject or equivalent qualifications) with the Ministry of Supply at research and development establishments mainly in the South of England, for work in physics, electronics, electrical, mechanical or aeronautical engineering, applied mathematics, metallurgy or chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.8/8A.

SENIOR LECTURER (well qualified, and preferably with some experience of the application of physics in industry) IN PHYSICS, and a SENIOR LECTURER (qualified to direct research and to undertake teaching in mathematics to honours degree or diploma in technology level) IN MATHEMATICS—The Principal, Institute of Technology, Bradford 7.

SENIOR PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The House Governor, St. Mary's Hospital, Paddington, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Atomic Energy. Miscellaneous No. 2 (1958): Decision of the Council of the Organisation for European Economic Co-operation establishing a European Nuclear Energy Agency and Convention on the Establishment of a Security Control in the field of Nuclear Energy, Paris, December 20, 1957. Pp. 19. (Cmnd. 357.) (London: H.M. Stationery Office, 1958.) 1s. net. [172

The United Kingdom's Role in Commonwealth Development. Pp. 18. (Cmnd. 237.) (London: H.M. Stationery Office, 1957.) 1s. net. [172

Report on Defence: Britain's Contribution to Peace and Security. Pp. ii+13. (Cmnd. 363.) (London: H.M. Stationery Office, 1958.) 1s. net. [172

Windsor Conference on Industry and Technical Colleges: Report of a Regional Conference held at the White Hart Hotel, Windsor on 15 October 1957. (Organised by the F.B.I. Southern Regional Council, with the co-operation of the Southern Regional Council for Further Education.) Pp. 46. (London: Federation of British Industries, 1958.) 2s. [202

Government of Northern Ireland: Ministry of Agriculture. Leaflet No. 48: Beef Production. Pp. 10. Leaflet No. 94: The Growing and Harvesting of Flax. Pp. 6. (Belfast: Ministry of Agriculture, 1958.) [242

Bulletin of the British Museum (Natural History). Geology. Vol. 3, No. 6: The Faunal Succession in the Caradoc Series of South Shropshire. By William Thornton Dean. Pp. 191–231+plates 24–26. 14s. Vol. 3, No. 7: A New Labyrinthodont (*Paracyclotosaurus*) from the Upper Trias of New South Wales. By David Meredith Seares Watson. Pp. 233–263+plates 27–31. 15s. (London: British Museum (Natural History), 1958.) [242

Parliamentary and Scientific Committee. Annual Report, 1957. Pp. 21. (London: Parliamentary and Scientific Committee, 1958.) [242

Anti-Locust Research Centre. Anti-Locust Bulletin No. 29: Laboratory Studies on the Inheritance of Phase Characters in Locusts. By Philip Hunter-Jones. Pp. 32. (London: Anti-Locust Research Centre, 1958.) 3s. 6d. [242

Training for Skill: Recruitment and Training of Young Workers in Industry. Report by a Sub-Committee of the National Joint Advisory Council. Pp. vi+36. (London: H.M. Stationery Office, 1958.) 2s. 6d. net. [242

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The Physics of Fluids, Vol. 1, No. 1 (January–February), 1958. Pp. ii+72. Published bi-monthly. Subscription rate: 11 dollars. (New York: American Institute of Physics, 1958.) [42

Florida State Museum. Report of the Director for 1956–57. Pp. 20. (Gainesville, Fla.: University of Florida, 1958.) [42

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Atlas Anatomique des Bois du Congo Belge. Vol. 3: Spermatophytes—Rosaceae, Mimosaceae, Caesalpiniaceae. Par Lucien Lebacq. Pp. 116+116 planches. (Bruxelles: Institute National pour l'Étude Agronomique du Congo Belge, 1957.) 500 francs. [42

Review of the National Research Council, 1957. Pp. 289+14 plates. (N.R.C. No. 4371.) (Ottawa: Queen's Printer, 1957.) 75 cents. [42

United States Naval Observatory. Circular No. 84: Positions, Areas and Counts of Sunspots, June, 1957. By Winifred Sawtell Cameron. Pp. 11. (Washington, D.C.: United States Naval Observatory, 1957.) [242

United States Department of Agriculture. Index-Catalogue of Medical and Veterinary Zoology. Supplement 7—Authors: A to Z. By Mildred A. Doss, Judith M. Humphrey and Dorothy B. Segal. Pp. i+1789–2139. (Washington, D.C.: Government Printing Office, 1957.) 1.25 dollars. [242

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Bulletin 33: Petrology and Red Coloration of Wall-Rocks, Radioactive Deposits, Goldfields Region, Saskatchewan. By K. R. Dawson. Pp. v+42+4 plates. 50 cents. Memoir 282: Subsurface Stratigraphy of the Mississippian Rocks of Saskatchewan. By G. H. MacDonald. Pp. 46. 50 cents. Annual Report for the Fiscal Year 1955–56. Pp. 113. 50 cents. (Ottawa: Queen's Printer, 1956 and 1957.) [242

The United States National Museum. Annual Report for the year ended June 30, 1957. Pp. v+137. (Washington, D.C.: Government Printing Office, 1957.) [242

National Science Foundation. Research Expenditures of Foundations and Other Non-profit Institutions, 1953–54. Pp. v+26. (NSF-58-2.) (Washington, D.C.: National Science Foundation, 1958.) [242

Disarmament and the United Nations: The "Partial-Measures" Approach and Other Decisions of the General Assembly's Twelfth Session. Pp. ii+30. (Reprinted from *United Nations Review*, December, 1957, Vol. 4, No. 6.) (New York: United Nations; London: H.M. Stationery Office, 1957.) 25 cents; 1s. 9d.; 1 Swiss franc. [242

Proceedings of the 6th Annual Meeting of the Japan Eeg Society held in Sapporo, July 2nd and 3rd 1957. Pp. x+141. (Sapporo: Research Institute of Applied Electricity, Hokkaido University, 1957.) [242

Smithsonian Contributions to Astrophysics. Vol. 2, No. 7: Distribution of Meteoritic Debris about the Arizona Meteorite Crater. By John S. Rinehart. Pp. ii+145–160. (Washington, D.C.: Government Printing Office, 1958.) 20 cents. [242

Evidence of Prenatal Function of the Central Nervous System in Man. By Prof. Davenport Hooker. (James Arthur Lecture on the Evolution of the Human Brain, 1957.) Pp. ii+41. (New York: American Museum of Natural History, 1958.) [242

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World Health Organisation. Medical Specialization: a Survey of Existing Legislation. (Originally published in the *International Digest of Health Legislation*, 1957, **8**, 561–596.) Pp. 40. (Geneva: World Health Organization, London: H.M. Stationery Office, 1957.) 1 Swiss franc; 1s. 9d.; 0.30 dollars. [242

Mount Stromlo Observatory: a History and Description of the Observatory; Its Work and Its Equipment. By A. K. Lojkine. Pp. ii+51. (Canberra: Research School of Physical Sciences, Australian National University, 1957.) [242

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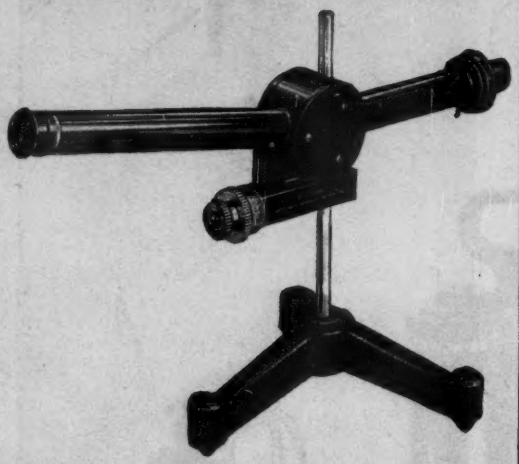

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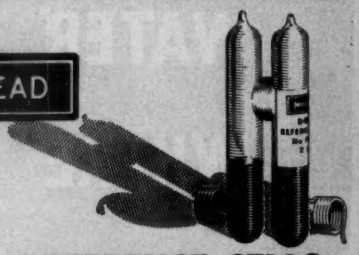

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